

Fall Migration and Nearshore Habitat Requirements
of Ross' Gulls (Rhodostethia rosea)

PART B

The Distribution, Abundance, and Movements of Ross' Gull
in the Alaskan Chukchi and Beaufort Seas
in Late Summer and Fall

by

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1. INTRODUCTION

Ross' Gull (Rhodostethia rosea) is one of the least studied of northern hemisphere seabirds. Known only from scattered collected individuals until late in the last century, it was not observed in numbers until 1881 when a large fall migration was seen at Point Barrow (Murdoch 1885) (Figure 1). Its breeding grounds were not discovered until 1905 when large numbers were found nesting in eastern Siberia on the wet tundra of the Kolyma and Indigirka river deltas (Buturlin 1906) (Figure 1). Little of substance has been added to our knowledge of the distribution of the species since these initial findings. A small number of nesting pairs have been recorded from a number of locations in the eastern and western arctic (Cramp 1983) but nesting in locations away from the Siberian breeding grounds appears to be temporary in nature and always involves small numbers of birds. Point Barrow remains the only location away from the principal breeding area where the species is both regular and abundant. Ross ' Gull is one of the few northern hemisphere species whose principal wintering areas remains unknown.

Following the initial observations of a fall passage at Point Barrow, observers have regularly recorded the species there in September and October (Bailey 1948, Gabrielson and

Lincoln 1959, Kessel and Gibson 1978). Few of the accounts of the passage have been detailed in nature and none were of systematic quantitative observations conducted over the duration of the movement. Almost all observers have commented on the eastward or northeastward direction of the movement. This direction is notable since essentially all subsequent observations show that movement of post-breeding birds at Point Barrow is west out of the Beaufort Sea and then southwest toward the Pacific Basin. The eastward and northeastward direction of the Ross' Gull, and the lack of observations of a return movement to the west, has led to speculation that the species winters in the Arctic Basin (Bailey 1948). This hypothesis has gained credibility (Blomquist and Elander 1981) as there has continued to, be a lack of winter observations of numbers of birds although there are increasing numbers of observations of vagrants in both the eastern and western subarctic (Bledsoe and Sibley, 1985). The belief in an Arctic Basin wintering area has persisted despite the almost complete ice cover and lack of daylight in the region for most of the winter.

Information on the habitat use and numbers of Ross' Gulls in Alaskan waters has been slow to accumulate since few vessels of opportunity are available during the period of ice formation. As oil and gas development has proceeded in arctic

Alaska over the last two decades, the status of Ross' Gulls in Alaskan waters has been an increasing concern. The exclusive nature of the Point Barrow passage implies that the majority of the world's population could be present in northern Alaska in fall making the species extremely vulnerable to a pollution event or other environmental hazard in Alaskan waters.

This report is a compilation of information on Ross' Gulls obtained in nine years of fieldwork from 1970 to 1986. Data obtained during cruises, land-based observations, and aerial surveys are presented and provide the first comprehensive information on the chronology, distribution, abundance and movements of Ross' Gulls in the Alaskan Beaufort and Chukchi seas in late summer and fall.

2. METHODS

2.1. Shipboard observations

2.1.1. Transects

Censusing from vessels at sea was conducted using the same methods described in Divoky (1984) and Gould et al. (1982). Observations were made in 15-minute or 20-minute periods when the ship was steaming at more than four knots. These periods

are referred to as both "transects" and "observation periods" in this report. Observation periods from cruises conducted from 1970 to 1972 were 20 minutes in length and those from 1975 to 1986 15 minutes in length. One or two individuals observed from the flying bridge of the vessel (average height 18 m above sea level) using 7x or 10x binoculars. All birds to 300 m to one side of the vessel were counted and information on age and activities recorded whenever possible. Flight direction was recorded when an individual or flock was observed in directed flight. The total area censused in each transect was determined and a density of birds per sq. km computed.

For each observation period the location and ice conditions were recorded. Ice condition categories included: no ice (no ice visible - also referred to as open water), visible ice (ice seen during some part of the observation period but not present in the area censused) and ice present (ice encountered in the area censused). Areas with no ice present are also referred to as open water. When ice was present in the area censused the percent of the water's surface covered with ice was recorded.

Incidental observations of birds observed when the vessel was at oceanographic stations will be presented as appropriate to supplement the transect observations.

2.1.2. Migration watches

Migration watches were conducted from stationary vessels. Observations were made from the flying bridge in observation periods from 15 minutes to one hour. All birds observed to 300 m were recorded and their flight direction and altitude recorded. Age was obtained whenever possible. Information from migration watches is combined with that on bird movements from transects when data on movements from cruises is presented.

2.2. Observations from land

Observations of the movements of birds in nearshore waters were conducted from land. These observations were usually conducted in one-hour watches although shorter watches were conducted when visibility was reduced. All birds within 500 m of shore (both seaward and landward) were recorded and information on the number, direction, distance from shore and altitude were recorded. Movements of birds more than 500 m from shore were recorded only when they appeared to be substantially larger than movements closer to shore.

While the actual direction of flight was recorded for all migrants observed at Point Barrow, only two flight directions

are presented: east (leaving the Chukchi and entering the/Beaufort) and west (moving in the opposite direction).

Observations from Point Barrow were made at a height of two to six meters usually made with 7x or 10x binoculars. A 40x telescope was used at those times when much migration was occurring outside of 300 m.

To obtain information on the passage of birds per day those hours when no observations were conducted were estimated to be the average of the preceding and following hours of observation.

2.3. Aerial censusing

Aerial censusing of shoreline and nearshore habitats was conducted from either a Cessna 180 or a Twin Otter flying at 100 knots at an altitude of 150 feet. Observers recorded into a tape recorder all birds within 500 m on either side of the flight path. A third person kept track of the plane's location and the habitats being censused. The number of birds per linear kilometer were later computed.

In general, each section of coast was censused twice on a given survey. In areas with barrier islands the initial flight path was down the middle of the islands with all birds on the

south and north side of the island being counted. On the return flight the plane flew down the center of the lagoon. In areas without barrier islands the plane flew 300 m seaward of the beach.

2.4. Ice and meteorological information

Information on ice conditions recorded at the time of observations (biweekly ice syntheses published by the U.S. Navy, Suitland, MD) was used to study synoptic ice conditions in the western arctic. Information on the average historical ice information is from Brewer et al. (1977) . Meteorological information is from the National Climatic Data Center's summaries of the hourly observations obtained at Barrow.

3. DATA SOURCES

3.1. Cruises

From 1970 to 1986, observations of pelagic birds have been made on late summer and early fall cruises in the Chukchi (Divoky 1987) and Beaufort (Divoky 1984) seas (Table 1). The location of cruise tracks for the Chukchi Sea (Figure 2), and from Beaufort Sea (Figure 3) indicate where Ross' Gulls were absent or seen on less than one percent of the observation

periods. The location of cruise tracks for those cruises on which Ross' Gulls were regularly encountered are presented in Figures 4 to 6 for the Chukchi Sea and Figures 7 and 8 for the Beaufort.

3.2. Land-based Information

Incidental observations of approximately two hours per day were conducted at Point Barrow during the Ross' Gull movement in 1976 and systematic observations of migration were conducted in 1984 and 1986 (Table 2).

The locations of the Point Barrow observations are shown in Figure 9. In 1984 observations were conducted at Nuwuk at the tip of Point Barrow near the racon tower approximately 0.5 km southeast of the Point. In 1976 and 1986 observations were conducted from Birnik, the location of the "shooting station", at the base of the spit leading to the Point. Storm surges in late September 1986 eroded the base of the Point Barrow spit and access to the Point was not possible each day. Concurrent observations conducted at both Nuwuk and Birnik in 1984 found numbers and rates of movements to be similar at both locations.

3.3. Aerial surveys

Aerial surveys of the Chukchi and Beaufort Sea coasts (Table 3) were conducted on a regular basis in 1976 from June until October. Linear densities of bird groups encountered are presented in Divoky (1980). The dates and geographic extent of the 1976 aerial censuses conducted when Ross Gulls are in Alaskan waters (September and October) are listed in Table 3.

Limited aerial censusing was conducted in 1984, usually opportunistically in conjunction with logistic flights (Table 3).

4. STUDY AREA

For purposes of description, the Alaskan Chukchi and Beaufort seas have been divided into five regions (Figure 10): the southern, central, and northern Chukchi, and the western and eastern Beaufort. The Chukchi divisions were used by Divoky (1987) in an overview of the pelagic avifauna of that sea. For the northern Chukchi and Beaufort seas, the northern limit of the regions are defined by the mean position of the pack ice for the period 16-30 September (Brewer et al. 1977). Ice and sea surface temperatures presented below are also from Brewer et al. (1977). Brief descriptions of each region are:

4.1. Southern Chukchi Sea - 55,000 sq. km

This region is the most subarctic of the Alaskan sector of the Arctic Ocean. Currents passing north through the Bering Strait can raise summer sea surface temperatures to as high as 15 c. The area is ice free for four to five months of the year with ice decomposing in July and reforming in November. Because ice decomposes and forms rapidly in this region, the ice edge is present for a limited amount of time. All censusing in this region was conducted during the period when ice was not present.

4.2. Central Chukchi Sea - 140,000 sq. km

The influence of subarctic waters is much less than in the southern Chukchi, but still substantial since sea surface temperatures in summer can reach 10 . The ice edge is present in this region after late July, and in some years it remains in the region until ice begins forming in the fall. In most years the area is ice free during the period of maximum ice retreat in late September. Ice cover is extensive by the end of October.

4.3. Northern Chukchi Sea - 33,000 sq. km

This region has little influence from subarctic waters since the Bering Sea waters typically split into east and west components before reaching this region. The amount of open water in the region shows high annual variability. Typically the region has extensive open water only in September.

4.4. Western Beaufort Sea - 12,000 sq. km

The area is ice covered until late August and the extent of open water south of the pack ice in both this and the eastern Beaufort shows high annual variability. The advection of Bering Sea water into this region can raise sea surface temperatures over 5 C. Ice formation in the western and eastern Beaufort usually occurs in mid-October.

4.5. Eastern Beaufort Sea - 32,000 sq. km

Except for input from rivers this region has sea surface temperatures of 5 Co The region is little usually little influenced by the Bering Sea intrusion into the Beaufort Sea.

5. RESULTS

5.1. Shipboard Censusing

The cruises discussed in detail below are those on which Ross ' Gulls were observed. The frequencies referred to for pelagic censusing is the percentage of observation periods on which Ross' Gulls were observed. Those cruises on which Ross' Gulls were not observed provide important information on the absence of the species and are mentioned when appropriate.

5.1.1. Chukchi Sea

5.1.1.1. August 1975

Censusing was conducted from 1 to 20 August 1975 as far south as the Bering Strait with most observations being conducted in and next to the decomposing pack ice north of 69 N in the central Chukchi (Figure 11). Ice was visible or present during 65% of the observation periods. The principal ice edge was between 70 and 71 N but the area north of the edge had much open water and observations were conducted north to 71 55'N.

A flock of 17 Ross' Gulls was seen at 69 45'N, 168 30 W on 6 August where pack ice was visible to the north. The density for the transect was 15.8 b/km². On the following day two Ross ' Gulls were seen 25 km to the southwest when the ship was on station in an area where no ice was visible. The average density for the cruise was 0.04 b/km² and the frequency greater than 1%.

5.1.1.2. August 1976

Censusing was conducted at the ice edge in the Chukchi Sea east of 164 W (Figure 12). The cruise was just south of the ice edge with 51% of the transects having ice visible. Single Ross ' Gulls, probably the same bird, were seen on two adjacent transects on 11 August at 70 55'N, 162 30'W in an area of open water approximately 10 kilometers south of the nearest ice. Both transects had a density of 1.2 b/km². The average density for the cruise was 0.01 b/km² and the percent frequency 1%.

5.1.1.3. September-October 1976

Sampling from 22 September to 1 October 1976 covered a large geographic area (Figure 13). A range of habitats was censused from ice edge and pack ice in the northern Chukchi to open water south of Cape Thompson with sea surface temperatures as high as 7 C.

The observations at the ice edge were conducted at the time of maximum ice retreat. Ice was encountered only in the northern Chukchi north of 71 55'N where 83% of the transects were in or next to ice. While most transects in the ice were in areas with ice coverage of less than 33%, ice cover of 90% was encountered on six of the transects.

Ross' Gulls were absent the first two days of the cruise in open water northwest of Point Barrow and along the ice edge east of 161 W. The first Ross' Gulls were seen on 23 September at the ice edge west of 161 W. After that date they were common to abundant at the ice edge in the northern Chukchi, rare in the central Chukchi and, common but localized in the southern Chukchi (Figure 13, Table 4).

In the northern Chukchi, Ross' Gulls were found on 40% of the observation periods and averaged 4 b/km². The absence of the species at the ice edge east of 161 W is surprising given its abundance west of 161 W. The high density of 94.2 b/km² was in an area where large numbers of walrus were present on the ice and Ross' Gulls were associated with the walrus.

The central Chukchi had the lowest average density and frequency of the three regions of the Chukchi. No ice was encountered in this region or in the southern Chukchi. All

Ross ' Gulls encountered in the central Chukchi were seen west and north of Icy Cape on 1 October.

In the southern Chukchi, on a series of latitudinal transects west and southwest of Point Hope, Ross' Gulls were present in low densities on the southernmost transects on 28 September. None were seen on 27 September directly to the north.

Densities in the ice were consistently an order of magnitude higher than those in open water (Table 5). The percent frequency was significantly higher than in the open water . Densities and frequencies were high for all ice coverages sampled.

Flight directions of Ross' Gulls varied between the northern and southern Chukchi Sea (Table 6). Flight direction was recorded for 35% of the 338 Ross' Gulls recorded at the ice edge in the northern Chukchi, and the mean vector was 174 . In the southern Chukchi the mean vector for the flight direction was 348 . The large percentage of birds without a flight direction in the northern Chukchi indicates that a majority of the birds were not actively engaged in migration.

5.1.1.4. October 1976

Opportunistic observations were made from 7 to 9 October 1976 on a vessel in transit from Point Barrow to the Bering Strait (Figure 14). While the number of observation periods was limited (Table 7), the cruise allowed censusing of areas where observations had been made a week earlier. Ice was forming in the Beaufort and northern Chukchi seas during the observations. Ice was present on the Chukchi coast south to Peard Bay, and in the remainder of the Chukchi the ice edge was south of 71 N. Observations in the central Chukchi were in 10% ice cover, or with at least some ice visible, while no ice was seen in the southern Chukchi.

Only one Ross' Gull was seen in the central Chukchi, and two birds were seen west of Peard Bay on 7 October. In the southern Chukchi they were present from west of Point Hope south to the latitude of the Seward Peninsula at 66 30'N. Ross' Gulls averaged 0.3 b/km² and had a frequency of 18%.

5.1.1.5. September-October 1970

Observations were made 24 September to 17 October 1970 in transit from Point Barrow southwest to the open water south of the pack ice at the latitude of Icy Cape, and then three weeks

of censusing were conducted north of Cape Lisburne and south of the advancing ice edge (Figure 15). At the beginning of censusing the ice edge was just north of 70 N and there was a lead paralleling the shore from Point Barrow to Icy Cape. The majority of the Beaufort Sea was ice covered and ice cover in the nearshore Chukchi was extensive. During the census period the ice edge moved south to 69 N. Sampling in and at the ice edge was extensive, with 78% of the transects in areas with ice (Table 8).

Ross' Gulls were present just north of Point Barrow on 22 and 23 September before the start of the cruise and were observed during the entire cruise. They were common in the lead system from Point Barrow south to Icy Cape. At the southern edge of the pack ice Ross' Gulls were regular from 169 W to the Alaskan Chukchi coast with densities being highest in the area northwest of Icy Cape and Point Lay. South of the pack ice edge Ross' Gulls were less common.

The average density and frequency of occurrence of Ross' Gulls in ice were approximately three times that found in open water (Table 8). Birds were present on almost half of the observation periods in the ice. Transects with ice cover of 20% had densities substantially higher than open water but transects in other ice coverage had densities similar to open

water. An exceptionally high density of 120 b/km^2 was encountered in an area of 20% ice cover just southwest of Icy Cape on 2 October.

No movement indicative of migration was noted for Ross^r Gulls on this cruise. Ross ' Gulls frequently followed the ship and gathered in the vicinity of the ship when it was stopped on station.

5.1.2. Beaufort Sea

5.1.2.1. August-September 1971

Observations were made 18 August to 16 September 1971 between Point Barrow and the Canadian border in decomposing pack ice. Ross ' Gulls were seen on two of the 263 transects (Figure 6). Both observations were of single birds, resulting in densities of $1,2 \text{ b/km}^2$. One was seen on 11 September north of Harrison Bay, and two were north of Smith Bay on 14 September. The average density for the cruise was 0.001 b/km^2 with a frequency of 1%.

5.1.2.2. September 1976

Observations were made 6 to 18 September 1976 in the

extreme western Alaskan Beaufort Sea west of 151 W in loose pack ice (Figure 17). Ice cover in the Beaufort west of 145 W was 10 to 50% while east of 145 W the Beaufort was ice free from shore north to 70 30'N. Sixty-five percent (65%) of the transects had ice visible or in the transects (Table 9). The percent ice cover in the area censused decreased during the sampling period and the amount of water between the shore and ice edge increased.

The majority of Ross' Gulls were seen in a restricted area between 154 and 156 W and north of 72 N (Figure 17). One bird was seen at 152 W. Average density for the cruise was 0.2 b/km² and densities and frequencies were similar for open water and ice (Table 9). For ice habitats densities were highest when ice was visible and lowest when ice was present in the transect.

The first Ross' Gull was seen on 11 September, but most were observed after 13 September. The dates that birds were seen may be due in part to Ross' Gulls being most common in the area that was censused in the latter part of the cruise. It appears that Ross' Gulls were moving into the area during the first two weeks of September, however, since none were seen on a cruise in the western Beaufort Sea from 17 August to 3 September 1976.

5.1.2.3. October 1986

Observations were made 1 to 17 October 1986 from the extreme eastern Chukchi Sea directly adjacent to Point Barrow east to the eastern boundary of the Alaskan Beaufort at 141 W (Figure 18, Table 10). Sampling in the western Beaufort occurred from 1 to 7 October, with censusing in the eastern Beaufort after that date (Table 11).

The majority of the Beaufort Sea west of 145 W was ice free north to 72 N (Table 11). Ice retreat was pronounced in 1986, and the ice edge in the Chukchi was north of 73 N. During the sampling period ice cover increased to 80 to 100% in the majority of the Alaskan Beaufort. Sampling was divided equally between open water, areas with ice visible, and areas in the ice. In the western Beaufort sampling was conducted south of and at the ice edge and 56% of the observation periods had ice visible or within the transect. In the eastern Beaufort sampling was conducted in the newly forming ice north of the 200 m isobath, as well as in the open water south of the forming pack ice, with 82% of the transects in association with ice (Table 11).

Ross ' Gulls were present from the start of the cruise on 1 October until 15 October. The highest average densities were

in the western Beaufort where an average of 1.9 b/km² were present (Table 10). The lower average density in the eastern Beaufort is the result of transects north of the 200 m isobath where ice cover was 80 to 90 %. Excluding these transects the densities in the eastern Beaufort averaged 1.4 b/km².

Transects adjacent to the ice edge where ice was visible had the highest average densities (1.9 b/km²) approximately twice what found in open water (Table 10). Few birds were seen in areas with ice primarily because of the extensive ice cover in these areas.

The percentage of birds with a flight direction was ??%. In the western Beaufort the mean flight direction was 103 and the eastern Beaufort 3 (Table 12). Almost 50% of the birds in the western Beaufort were flying eastward, while in the eastern Beaufort the total was only 15%. In the eastern Beaufort 52% of the migrating Ross' Gulls were flying westward.

5.2. Land-based Migrant Watches at Point Barrow

5.2.1. September-October 1976

Incidental observations of Ross' Gull movements were conducted 27 September to 15 October 1976 for one to two hours

each day from the time Ross' Gulls first appeared until freeze-up (Table 13). Because the methodology differed from the migration watches in 1984 and 1986, the rates of passage from 1976 cannot be compared with those years. The direction of the movements is important **however**, since these observations provided the first indication that the eastward movement is followed by a westward movement back to the Chukchi. The eastward movement occurred during an extended period of winds from the northeast and east and the return movement occurred after the wind had shifted to the southwest (Table 13).

5.2.2. September-October 1984

Observations of the Ross' Gull migration were conducted from 2 September to 20 October 1984. On 18 September, twelve days before Ross' Gulls were observed, the ice edge in the Alaskan Chukchi was south of 72 N and the majority of the Beaufort Sea was ice covered south to 71 N. Freezing of lagoonal waters began on 1 October, with the ice seaward of the beach beginning to freeze on 5 October. At the beginning of the Ross' Gull migration on 1 October the ice edge was at 72 N due north of Point Barrow (and as far north as 73 N in the Chukchi Sea. The eastern Beaufort Sea was free of ice south of 71 30'N while the eastern Beaufort had patches of 50% ice cover

south to 71 15'N. On 22 October at the end of the migration, the Beaufort Sea was 90-100% ice covered and the extreme western Chukchi was frozen to 160 W. In the central Chukchi the ice edge was at 72 N but was close to 71 N adjacent to Siberia and Alaska.

Ross ' Gulls were not seen until 30 September but were common after that date until 20 October (Table 14). The observed movements (Table 14) and the projected totals (Table 15, Figure 19) show that the birds were essentially moving both east and west. When discussing the observations at Point Barrow, a bird going east is leaving the Chukchi Sea and entering the Beaufort, and while a bird moving west is doing the reverse. The majority of the birds flying east flew northeast as they paralleled the Chukchi shore to the tip of Point Barrow; they then continued to parallel the shoreline as they flew southeast into the Beaufort Sea. A small percentage of birds were observed crossing the base of the spit leading to Point Barrow (at the location of observations in 1976 and 1986 in Figure 9). Observations from 1986 show that the number crossing the base of the spit was 10% of the total birds passing by its base. Birds moving westward were flying principally southwest. When no extensive shorefast ice was present, birds approached the tip of Point Barrow from the east or southeast and then followed the Chukchi coast to the southwest.

For the first 12 days of the migration almost all movement was to the east, but after 12 October the net movement was westward with some eastward movement continuing until 16 October. For the eastward movement, the observed total exceeded 11,000 birds and the projected total was 16,500 (Table 15). Because the movement was almost exclusively east for twelve days (30 Sept. -11 Oct.), it is unlikely that the totals for the eastward passage included birds that were being counted twice until 12 October. During this period 10,000 birds were observed flying west with a projected total of 15,000. Thus the eastward movement at Point Barrow involved a minimum of 10,000 birds and probably approximated 15,000.

The duration and magnitude of the westward movement was substantially less than the eastward movement, with an observed total of 5,000 (Table 14) and projected total of 7,000 (Table 15). Essentially all of the westward movement occurred after 12 October, and for the last four days of the migration, movement was exclusively westward.

Wind conditions during the east and west passages (Table 15) show that during the period of exclusive eastward movement, winds blew from the east and northeast with a small angular deviation. During the westward movement the average wind was from the west but the angular deviation was large and winds

ranged from southeast to north. During both movements the average wind speed was 16 miles per hour.

5.2.3. September-October 1986

At the start of observations on September 23, 1986 the ice edge in the Chukchi Sea was north of 73 N. The western Beaufort was ice free north to 72 N while the eastern Beaufort had scattered patches of ice of 10-30% south of an ice edge at 72 N. At the end of observations on 18 October the ice edge in the Chukchi and the Beaufort extended from 71-72 N. Ice was forming rapidly, and on 21 October the entire Alaskan Beaufort had 80-100% ice cover. In the Chukchi the nearshore zone from Point Barrow to Peard Bay had 40-60% ice cover, the ice edge was at 71 N, and much of the Soviet Chukchi was ice covered.

Ross ' Gulls were not observed until 26 September (Tables 16 and 17). From that date until 6 October small numbers were seen moving both to the east and west. After 6 October movements in both directions increased but were primarily to the west. The movement on 11 October of 2,637 observed and 3,846 projected was the by far the largest during the observation period.

The observed and projected totals for the eastward movement were approximately one quarter that of the westward (Table 17, Figure 20). We did not observe the end of the migration in 1986 and these are estimated passages until 18 October only.

Unlike 1984, wind direction was highly variable and wind speed weak (Table 18). Wind direction had a mean angle of 194 SSW with a standard deviation of 75 . The average wind speed was 10 m.p.h.

5.3* Aerial Surveys

5.3.1. 1976 Surveys

No Ross ' Gulls were observed on aerial surveys (Figure 21) before mid-September. Only those coastal sections where the species was encountered (Figure 21) are presented, although censusing was conducted from Cape Lisburne to Demarcation Point. No Ross' Gulls were observed until the 23 September flight (Table 19), when they were encountered only in the Beaufort Sea. Numbers were highest in the Plover Islands where the density in birds per linear km doubled from 23 September to 4 October. Both of these censuses extended east to at least Prudhoe Bay but no Ross' Gulls were observed east of Cape Halkett. Nearshore waters froze on 9-10 October causing a

decrease in shoreline densities of gulls. Ross ' Gulls were encountered on the Chukchi coast later than the Beaufort and only in small numbers.

5.3.2 1984 Surveys

Aerial censuses of the extreme western Beaufort Sea and Plover Islands were conducted to determine if any specific feeding aggregations could be located in areas where other surface feeding species congregate in August and early September (Divoky 1984). No aggregations were encountered.

A census of the Chukchi Sea coast from Point Barrow to Wainwright on 8 October found migrating Ross' Gulls common within 500 m of the beach from Point Barrow to just north of Peard Bay (10 birds per linear km). No Ross Gulls were observed south of the Peard Bay area and it appeared that birds were coming off the Chukchi Sea and encountering the Chukchi coast at Peard Bay. The projected passage at Point Barrow for 8 October was 500 birds.

6. DISCUSSION

6.1. Timing of occurrence in arctic Alaska

The period when Ross' Gulls are present in numbers in the Alaskan Chukchi and Beaufort seas is limited to the six to eight week period from mid-September to late October or early November. During the breeding season, from late May to late July, Ross' Gull is apparently an uncommon vagrant in arctic Alaska. Land-based observations from Wainwright to Cooper Island show that single birds or pairs could be expected to be irregular in the pelagic Chukchi and at least the extreme western Beaufort during this period (Bailey 1948, Kessel and Gibson 1978, Divoky unpub.). While most sightings during this period have been in the general region of Point Barrow, this is almost certainly due to the number of observers in that region.

Ross ' Gulls depart the breeding grounds shortly after our pelagic observations begin in mid-July. Although the breeding area is only 900 nautical miles from Point Barrow there is a minimum of six weeks between the time of departure from the colonies to arrival in Alaskan waters. This extended period of time implies that Ross' Gulls do not move directly to Alaska from the breeding area. Ice begins forming in the waters north of Siberia west of 175 E from mid- to late-September, two weeks

to a month before ice formation usually begins in Alaskan waters. This is approximately the time that Ross' Gulls move to Alaskan waters and it may be that Ross' Gulls occupy the area north of the breeding ground or the Chukchi Peninsula until freeze-up occurs.

In the Chukchi Sea during 263 hours of observation from 16 July to 22 September Ross' Gulls were seen on 3 of 1,151 observation periods. These three sightings were all in early August with none being seen from mid-August to mid-September. This indicates that these birds were non-breeding vagrants and did not represent the start of the fall migration. In the Beaufort Sea, 1,758 observation periods (480 hours) were conducted from 2 August to 10 September with no Ross' Gulls being seen.

The extreme paucity of Ross' Gulls in Alaskan waters before the species arrives in numbers in mid- to late-September is somewhat surprising in light of the observations in the Arctic Ocean west of the breeding grounds. In the pack ice between Franz Josef Land and Greenland, Meltotte et al. (1981) found Ross' Gulls to be common in the pack ice from early July to early August. Other summer observations of concentrations in that area of the arctic (Lovenskiold 1963) indicate that nonbreeding Ross' Gulls are probably regular there.

Sampling in mid-September was not extensive but it appears that Ross' Gulls arrived in numbers in Alaskan waters sometime between the end of the first week and the start of the last week in September. On two cruises in 1970 and 1976, we found Ross ' Gulls to be common at the ice edge at the start of the last week in September. On two different years (1971 and 1976) Ross ' Gulls were first seen in the Beaufort on 11 September, although both times in small numbers. At Icy Cape Lehnhausen and Quinlan (1981) had 18 sightings of Ross' Gull between 31 August and 3 September, indicating that early migrants can arrive two weeks earlier than the pelagic observations indicate.

6*2. Summary of Occurrence in Arctic Alaska

From the last week in September until the end of observations in late October, Ross' Gulls were regularly encountered in the Alaskan arctic. It appears that Ross' Gulls occupy the Alaskan Beaufort and Chukchi until freeze-up. Based on pelagic observations and migrant watches, Ross' Gulls leave the Beaufort from mid- to late-October when ice cover east of Point Barrow is nearly complete. Ross ' Gulls are present in the Chukchi Sea in late October when our observations end. If, as proposed in this report, Ross' Gulls move south with the Chukchi Sea ice edge to the Bering Sea, Ross ' Gulls would leave the Alaskan arctic when ice cover is

nearly complete. This can occur anywhere from late October to early December (Brewer et al. 1977).

6.3. Movements

A knowledge of the movements of Ross' Gulls in Alaskan waters is important in interpreting the pelagic densities and other information on the species, as well as assessing the vulnerability of the species in specific regions. While the post-breeding movement from Siberia to Point Barrow has been known since early in this century, the movements of birds in Alaskan waters has been unknown until the acquisition of the information presented in this report.

6.3.1. Movement from Siberia to Alaskan waters

The movement of Ross' Gulls to Alaskan waters has not been well documented, but based on observations at a number of points north of eastern Siberia (Dementev and Gladkov 1969, Pleske 1928) it appears to be a rather direct eastward movement. It is not known if all of the breeding population and newly fledged young move eastward to Alaska when they leave the breeding grounds. That some birds might move west from Siberia needs to be considered a possibility in light of the numbers of nonbreeders encountered west of the breeding grounds during the breeding season (Meltofte et al. 1981).

The distance from the breeding grounds to Point Barrow is only 900 nautical miles although it takes Ross' Gulls six to eight weeks to cover the distance. Because Ross' Gulls arrive en masse in late September/ with few early migrants being seen, it appears that the species remains in Soviet waters until sometime in September before moving to Alaska. As mentioned above, the Arctic Ocean north of the eastern Siberia begins to freeze in mid- to late-September.

Once in Alaskan waters Ross' Gulls apparently move in a short period of time to the Point Barrow region and western Beaufort Sea. The movement into the Beaufort can occur offshore since in both 1975 and 1976 Ross' Gulls were encountered offshore in the western Beaufort before numbers of birds were seen passing Point Barrow.

Pelagic observations in the Chukchi Sea in late September 1976 were conducted at a time when Ross' Gulls were passing east past Point Barrow. These pelagic observations show that a time when a directed eastward movement is occurring at Point Barrow, Ross' Gulls are found as far south as 67° 30'N in the southern Chukchi and as far north as the ice edge at 72° 50'N, with the majority of the birds appearing to be at the ice edge. The percentage of birds at the ice edge that were recorded as migrating is not large and the observation of large

feeding flocks at the ice edge indicates that birds are not migrating directly through the region. The range of directions of birds at sea (Table 6) indicates that birds are not moving directly across the Chukchi to the Beaufort. The mean direction of birds at the ice edge in the northern Chukchi was SSE, and in the southern Chukchi NE. The angular deviation was large in both regions. Both of these mean directions indicate that birds were moving to the central Chukchi and it is possible these birds could have passed into the Beaufort during the period of visible eastward movement which ended on 2 October.

6.3.,2 Movements at Point Barrow and in the Beaufort Sea

The eastward passage of Ross' Gulls at Point Barrow has been known for over a century and has resulted in much speculation. Unfortunately, up until the present study, essentially all observations were incidental in nature. The first published records of the fall passage were made by Murdoch (1885). From 28 September to 22 October 1881 he found Ross' Gulls sometime exceedingly abundant. The following year he observed Ross Gulls from 21 September through 9 October. In 1897 there was only a small passage and it apparently occurred primarily in September {Stone 1900}. Bailey was the next to record Ross' Gulls and found them common in the Wainwright area

in mid- and late-October 1921. Both Abbott (1929) and Bent (1929) reported on the 1928 migration when Ross' Gulls appeared on 26 September and were abundant on that and the following date.

There are thus records from 1881, 1882, 1897, 1921, and 1928. Since no movement occurred in 1897, there are only four years when the Ross' Gull migration was observed. None of these years had daily systematic observations conducted and given the incidental nature of these observations it is not surprising that no return movement to the Chukchi Sea was observed. In addition to these six years there is the narrative of Brewer in Bailey (1948) in which he summarized his observations at Barrow where he was a resident.

The direction of the movement of Ross' Gulls at Point Barrow is important for a number of reasons. In terms of determining the species' probable wintering area, a completely eastern movement would indicate a wintering area in the Arctic Basin. A eastern movement followed by a westward movement would make a Pacific Basin wintering area most likely. The flight direction is also important in assessing the vulnerability of Ross' Gulls in Alaskan waters. A late westward movement, such as we observed, indicates that the Chukchi is important to the species for an extended period of

time, perhaps as much as a month longer than what would be assumed if there was no return from the Beaufort Sea.

The observations presented in this report show that for two of three years (1976 and 1984) the migration at Point Barrow began with an eastward movement followed by an westward movement. In all three years (1976, 1984 and 1986) the visible migration ended with a westward movement. A late westward movement was also observed in 1987 (Sanger, Part C of this report) . In both 1976 and 1984 the observed westward movement was less than the east and the difference in the movements visible from land appeared to be due to the formation of nearshore ice causing the westward movement to be offshore or over a broader front in the nearshore. In one year (1986) no major eastward movement was observed although a major but irregular westward movement was.

The reasons for the differences in the 1984 and 1986 Point Barrow migrations will require analysis of meteorological and oceanographic data. The extent of the southwest passage after 5 October 1986 and the numbers seen in the pelagic Beaufort in early October, indicate that an unobserved eastward passage had occurred prior to that date. There is little possibility that the passage occurred at Point Barrow prior to the start of our observations on 23 September. Incidental observations made

almost daily on the Chukchi Sea beach between the town of Barrow and the base of Point Barrow did not find Ross' Gulls to be present prior to 27 September (J. C. George, pers. comm.), and it appears likely that the migration occurred out of sight of land.

The distance of the ice edge north of Point Franklin Peard Bay at the start of migration may be revealing since Ross' Gulls apparently move from the pelagic waters to the Alaskan Chukchi coast between Peard Bay and Point Barrow. If ROSS' Gulls moving through the Chukchi Sea eastward from Siberia are primarily at the ice edge, as our pelagic observations indicate, when the ice edge is atypically far north the eastward movement into the Beaufort may occur out of sight of land at the ice edge north of Point Barrow. In 1984 three days after Ross' Gulls were first seen at Point Barrow the ice edge was 70 nautical miles north of Point Franklin. In 1986 three days after the first observation the distance was 120 nautical miles.

The differences in numbers between the eastward and westward movements in 1984 are apparently due to ice conditions and may be important in explaining the fact that previous observers have not seen a westward passage. The eastward passage consisted of birds moving northeast up the Chukchi

coast in a rather narrow corridor from the beach to 300 m seaward. The average altitude of flying birds was 7 m and the average distance from land 29 m. The majority of the eastward passage occurred when little or no ice was present in the nearshore zone and migrating birds frequently dipped to the water's surface to feed.

The westward passage in 1984 occurred during a period when ice was rapidly forming and landfast ice extending 300 to 500 m offshore occurred on both the Chukchi and Beaufort coasts in the Point Barrow area. During the westward passage birds were observed flying over a broad front from the base of Point Barrow to the offshore limit of visibility north of the Point. Birds averaged 13 m in altitude and 61 m from shore.

A similar situation occurred in 1976 when a major eastward passage was observed at Point Barrow in late September with a smaller return passage. Extensive freezing of the nearshore had occurred between the two movements and observations with a 40x telescope during the minor westward movement indicated that there was a larger movement occurring offshore.

It appears that the extent of the freezing of nearshore waters at Point Barrow could directly influence the extent of the westward migration visible from land. This would partially

explain why so many previous observers have failed to detect a westward passage. Still, the apparent lack of observations of the westward movement is surprising since in each of the four years when systematic observation have been made, a final westward passage was observed. It seems likely that even in years when previous observers noted some westward movement it was so much less than the eastward passage that it was not mentioned.

Pelagic observations also demonstrate the bidirectional nature of Ross' Gull movements in the Beaufort. In early October in the western Beaufort the mean direction is to the east while in mid-October east of 152° W movement was to the north.

During the two periods when major eastward movements were visible (in 1976 and 1984) the wind at Point Barrow was from the east or northeast with little angular variation (Table 18). To examine the frequency of favorable winds at Point Barrow the average daily wind directions for all days in September and October from 1975 to 1987 were categorized as to being favorable for eastward migration (from 360-135°) or westward migration (180-330°) (Table 20). The last five days of September were found to have the highest percentage of days with winds for eastward movement and the lowest percentage of winds

favorable for westward. After that date the percentage of winds favorable for westward passage increases. The meteorological information before 1975 is being examined to determine if this pattern is present when all available data (1954-87) is considered.

Upwind migration is apparently uncommon in birds and is poorly understood (Richardson 1978). Timson (1976) found the rate of westward migration of larids at Point Barrow to be highest with headwinds. She believed that this was due to ice being blown onshore on the Chukchi coast and increasing feeding opportunities due to increased prey availability next to the ice.

An examination of average monthly wind directions for 1975-87 shows that in nine of 13 years the average September wind direction is favorable for eastward passage. For the two years we observed a major eastward movement (1976 and 1984) the average September wind directions were 70 and 80 respectively. In 1975 when no passage was observed and Ross' Gull apparently did not enter the Beaufort in numbers (Divoky unpub.) the average wind direction was 29 , and in 1986 when no eastward movement was seen the wind direction was 20 . 1986 was also notable for being the only year during which the average wind direction in October was not between 360 and 90 .

Annual wind conditions are being examined further, but it appears that the eastward movement at Point Barrow is most pronounced in those years when the average wind direction in September is from the east. During those years the majority of the eastward movement occurs when the wind is from the east or northeast.

6.3.3. Reasons for the late fall movement

Speculation on the factors causing the movement into the Beaufort are hindered by a lack of information on the percentage of the birds in the Chukchi that enter the Beaufort and a complete lack of information from the Soviet Chukchi. While the movement of Ross' Gulls to and from the Beaufort Sea is well documented in this report, and the portion visible from Point Barrow appears to be related to wind direction, the reason for the movement is less clear.

After Ross' Gulls move to the Chukchi Sea in late September a certain number could be expected to move to the Beaufort Sea before the ice edge advances to south of Point Barrow. The movement to the Beaufort appears to be a directed one and not the result of simple dispersion, however. The reasons for this movement are not clear but would appear to be related to prey availability. Prey availability at the Chukchi ice edge may

not be sufficient to support the numbers of Ross' Gulls that arrive there in mid- to late-September.

The littoral, nearshore and pelagic habitats directly east of Point Barrow and north of the Plover Islands have high densities of surface feeding species from early August to mid-September (Divoky 1984). These densities are the highest for surface feeding species for the northern and central Chukchi and the entire Beaufort (Divoky 1984 and 1987). While the aerial censusing of nearshore habitats shows Ross' Gulls to be most abundant in the extreme western Beaufort, the pelagic censusing from 1986 shows Ross' Gulls to be well dispersed throughout the entire Alaskan Beaufort.

A directed eastward movement into the Beaufort Sea in the fall of 1984 was observed for Short-tailed Shearwaters (Puffinus tenuirostris) and Ivory Gulls (Pagophila eburnea) (Divoky unpub.), with substantial portions of the numbers in the northern and central Chukchi entering the Beaufort. Well over 100,000 shearwaters were observed flying east past Point Barrow in late September 1984. Less directed eastward movements were observed for Glaucous Gulls (Larus hyperboreus) and Black-legged Kittiwakes (Rissa tridactyla). These data are being analyzed and should shed light on the Ross' Gull movements at Point Barrow.

6.3.4 Late fall movements in the Chukchi Sea

In 1970 observations were conducted in the Chukchi Sea in late September and early October, apparently after the return movement of Ross' Gulls from the Beaufort back to the Chukchi. At the beginning of observations the Beaufort Sea was almost completely ice covered and, if Ross' Gulls had entered the Beaufort that year, the majority of the Ross Gulls had apparently returned to the Chukchi. The observations of Ross' Gulls were notable that year for the lack of directed movement indicative of migration. Flocks were encountered feeding or resting at the ice edge and groups of Ross' Gulls were attracted to the ship both when it was steaming and stationary. This was the only cruise when ship following was regularly recorded. It appeared that Ross' Gulls were resident at the Chukchi ice edge at this time and were moving south with the advancing ice edge.

During the 1970 cruise, ice was rapidly forming and ice cover in the arctic basin adjacent to the Chukchi was essentially complete. There appears to be little doubt that the Ross' Gulls moved south with the ice edge to the Bering Sea. They are well known at Gambell on St. Lawrence Island in November and December (Fay and Cade 1959, Scaly et al. 1971, Kessel and Gibson 1978) but apparently not seen in numbers.

This is not surprising since Ross' Gulls would be passing that location at the time of ice formation and could be expected to occur offshore out of sight of land.

6.3.5. Possible wintering area

The wintering area of the Ross' Gull appears to be in the northwestern Pacific Basin, probably in the area of the Sea of Okhotsk. The November and December St. Lawrence Island observations indicate that Ross' Gulls move west after passing through the Bering Strait. They are not present in the Alaskan Bering Sea in winter and spring but there are spring observations of regular movements northward in Siberian river valleys between the Sea of Okhotsk and the breeding grounds (Dementev and Gladkov 1969). A summary of Ross' Gull movements in Alaskan waters is presented in Figure 22.

6.4. Distribution and abundance

From late September until mid-October Ross' Gulls can be expected to be encountered anywhere from the extreme western Alaskan Chukchi Sea to the extreme eastern Alaskan Beaufort. After their arrival in the Chukchi, Ross' Gulls are found in high densities at the ice edge in that sea. Two cruises had densities over 4 b/km² and percent frequencies of 40-45%.

Their geographic distribution appears to be dependent on the location of the ice edge. In 1976 it was north of 72 N and in 1970 it was in the central Chukchi near 70 N. Sampling in the open water south of the ice found average densities of 0.1 to 0.7 b/km² and frequencies of 8-20%

Censusing in the Beaufort during the period when Ross' Gulls are present is limited, with most observations coming from 1986. It appears that at least in early September Ross' Gulls are restricted to the western Beaufort with densities of 0.2 to 0.3 b/km² and frequencies of 7%. In October the species is found throughout the Beaufort with the western Beaufort having an average density of 1.7 b/km² and a frequency of 43%. The eastern Beaufort, where ice coverage was more extensive, had an average density of 0.6 b/km² and a frequency of 24%.

Ice appears to play a major role in determining distribution and abundance in the Chukchi with substantially higher densities and frequencies of Ross' Gulls when ice was present. In the Beaufort, however, densities and frequencies in the ice were similar to open water. This might be due to the limited extent of open water in the Beaufort which allows birds in open water to be rather close to the ice edge.

During the period when Ross' Gulls occupy the Alaskan arctic they are a major part of the pelagic avifauna. From 22 September on they are the most abundant species in all regions (Figure 10) but the southern Chukchi. At the time when the ice edge is present in the southern Chukchi in late fall they are almost certainly the most abundant species in that region.

6.5 Population estimates

No population estimate has previously been made for Ross' Gulls. Like most tundra-nesting seabirds adequate censusing of breeding habitats has not been conducted. The rarity of Ross' Gulls on a global basis makes a population estimate of more interest than for widely distributed species.

The percentage of the world's population of Ross' Gulls that visits Alaskan waters is not known. It appears that a substantial part of the nonbreeding population is present in the vicinity of Franz Josef Land in summer, although it is possible that these birds could move east later in the year (Meltofte et al 1981). The percent of the breeding population and birds of the year that move east to Point Barrow is also unknown. It is also unknown what percentage of the birds that move into the Chukchi enter Alaskan waters. Thus the estimates for Alaskan waters should be considered a minimum estimate for

the world's population and would need to be increased by the numbers found outside of Alaskan waters in the fall.

6.5.1. Population estimate from pelagic censusing

Two data sources are available for population estimates: pelagic censusing and migrant watches. Pelagic censusing provides information on b/km^2 that can be extrapolated by the area censused to provide a population estimate. Such a technique was used by Gould et al. (1982) for the Bering Sea and Divoky (1987) for the Chukchi. The reliability of such estimates is directly related to the degree of stratification of the area sampled. For this reason Gould et al. (1982) called their estimates "population estimate indices".

The information on pelagic distribution and abundance presented in this report that provides the best information for a Ross' Gull population estimate is the 1970 cruise in the Chukchi. This cruise apparently occurred at a time when birds had returned from the Beaufort, and the ice edge was at the latitude of Icy Cape with a minimum distance from the USSR Convention Line to Icy Cape of 220 km. No satellite imagery is available for determining the width of the ice fringe, but on the basis of the shipboard observations the ice edge habitat sampled was a minimum of 20 km in width and as wide as 37 km

at some points. Thus, the ice edge habitat was a minimum of 4,400 Sq. km and a maximum of 8,140 sq. km. Using 4.7 b/km^2 the minimum population present in the area is 20,700 and the maximum 38,000.

6.5.2. Population estimate from migrant watches at Point Barrow

The Point Barrow migrant watch in 1984 provides the best estimate of the population entering the Beaufort Sea. The initial movement from 30 September to 12 October was 14,750 birds projected eastward, with only 1,000 projected westward (600 of these on 12 October). There is little chance that the eastward movement included birds that had returned to the Chukchi and were counted twice, so that a minimum of 15,000 Ross' Gulls moved into the Beaufort Sea during the initial period.

The actual number of Ross' Gulls entering the Beaufort is certainly much higher and would include birds passing east for the first time past that date and birds that moved into the Beaufort out of sight of land. In 1986 sampling in the western Beaufort found an average density of 1.9 b/km^2 . Assuming an area of 12,000 sq. km, an estimated 23,000 Ross' Gulls were present in the Beaufort Sea during that period.

6.5.3. Age classes in the population

Ross ' Gulls are present in Alaskan waters two to four months after the end of the breeding season and the population consists of adults, juveniles (birds fledged in the previous year) and immatures (birds fledged in the current year). The number of birds present in Alaskan waters thus depends on the breeding success for the two previous breeding seasons and winter survival. Ross ' Gulls have an average clutch size of 3 eggs, although no information is available on fledging success . A breeding success of 66% would not be out of the ordinary for an arctic larid and it is conceivable that if two chicks per nest were fledged that half of the birds present in Alaskan waters could be young of the year.

In 1970 approximately 50% of all Ross' Gulls observed were subadults. The 1984 observations at Point Barrow were remarkable in that less than 5% of all birds observed were subadults. 1984 appeared to be a year of extremely low breeding success, and the number of birds passing Point Barrow in some years could be twice what was observed in 1984.

6.6 Regional occurrences (Figure 10) and abundance

6.6.1. Southern Chukchi Sea

Our observations from the region indicate that Ross' Gulls are present but not as abundant during the initial period of movement to Alaskan waters as later, when most birds appear to be moving eastward at the ice edge. Sampling during this period is limited to 1976 but during that year an average density of 0.5 b/km^2 were encountered in early October. During this period Ross' Gulls were limited to the area directly north of the Bering Strait and south of the latitude of Point Hope. During this period in Alaskan waters west of $166^{\circ}30'W$ and south of $68^{\circ}N$ (an area of 16,000 sq. km), approximately 8,000 Ross ' Gulls might be present in this area that is over 200 nautical miles south of the ice edge.

The area is one where high densities of phalaropes were found in late September and early October, indicating that densities of zooplankton at the surface were high. Densities of surface feeding species were low in the area until late September, however.

If, as proposed in this report, Ross' Gulls move south with the advancing ice edge in late fall. the entire population of Ross ' Gulls in the Chukchi Sea passes through this region between late October and December. Ice formation is rapid at

this time, however, it is likely that the birds move quickly south through the region.

6.6.2. Central Chukchi

This region has the highest pelagic densities and also the longest period of occupation among the five regions discussed here, although the presence of the ice edge appears to play a major factor in determining the densities and period of occupation. Ross ' Gulls are present moving to the Point Barrow region, some may remain in the region during the movement into the Beaufort, and after the return to the Chukchi Sea Ross' Gulls are abundant at the ice edge.

Ross ' Gulls are found in the northern nearshore waters of this region both during the eastward movement to the Beaufort and apparently to a lesser extent, during the return westward movement.

6.6.3. Northern Chukchi

The importance of this region to Ross' Gulls could be expected to vary annually depending on the location of the ice edge during maximum ice retreat. In most years much of the ice edge would be present in this region during the eastward

movement and large numbers could be expected to occur in the region. In those years when the ice edge is present in the central Chukchi in mid- and late-September the use of Ross' Gulls could be expected to be low. By the time birds return from the Beaufort in mid-October the region is usually ice covered.

6.6.4. Western Beaufort

Ross' Gulls are present in this region from mid-September to mid-October. This region has the highest littoral densities of Ross' Gulls of any region of the Alaskan arctic. Before the arrival of Ross' Gulls the nearshore and pelagic habitats of this region have high densities of surface feeding species (Divoky 1984). The processes that concentrate zooplankton in the vicinity of the Plover Islands apparently persist to freeze-up.

6.6.5. Eastern Beaufort

From early August to mid-September this region has low densities of surface-feeding species (Divoky 1984), but Ross' Gulls were common during limited censusing from one year. The average period of occupancy of the region is generally short (two weeks) since ice cover is usually extensive by mid-October.

7. CONCLUSIONS

1. Ross ' Gulls are a regular and major component of the pelagic avifauna of the Alaskan Chukchi and Beaufort seas in fall. Prior to mid-September they are present irregularly in extremely small numbers in the Chukchi Sea and do not become common in Alaskan waters until mid- to late-September.

2. During the period when Ross' Gulls are present in Alaskan waters they move from the Soviet Chukchi to the Point Barrow region and then into the Beaufort Sea in late September or early October. There is then a return movement into the Chukchi in mid- to late-October. The percentage of Ross' Gulls in the Chukchi that enter the Beaufort is unknown. After returning from the Beaufort Ross Gulls stay at the Chukchi ice edge apparently moving into the Bering as the Chukchi freezes over in November.

3. Ross ' Gulls make extensive use of the Chukchi two to three months between September and November. Densities are highest at the Chukchi ice edge in late September and early October. Low densities are present in open water south to the Bering Strait.

4. For reasons not yet known **Ross' Gulls** enter the Beaufort Sea **from late** September to mid-October and remain **until** ice cover is nearly complete. **Ross' Gulls** are equally **common** at the ice edge and in open water in the **Beaufort**, with densities lower than at the **Chukchi** ice edge.

5. The eastward **migraticn** at Point **Barrow** is most visible during those years and time Periods when winds are from the east. **Wes:ward** movement from the **Beaufort** occurs during more **variable vinds** conditions but appear to be most pronounced when **the wind** is from the **west**.

6. **Ross ' Gulls** are found in shoreline habitats from the village of **Wainwright** on the **Chukchi** coast to Cape **Halkett**, adjacent to **Harrison Bay** in the **Beaufort**. The highest shoreline densities are found from Point Barrow to Tangent Point. Coastal densities appear to be related to the abundance and availability of **zocplankton** concentrations.

?. The population of **Ross' Gulls** in Alaskan waters in **fall** is somewhere between 20 and 40,000 birds with the number entering the **Beaufort** between **15 and 25,000**.

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Table 1. Dates, vessels, and number of observation periods for cruises in the Alaskan Chukchi and Beaufort seas.

Dates of observations	Vessel	15-minute observ. per.	Cruise track
<u>CHUKCHI SEA:</u>			
16-25 Jul. 1981	POLAR STAR	260	Figure 2
01-20 Aug. 1975	GLACIER	359	Figure 2
07-14 Aug. 1976	"	133	Figure 2
07-08 Aug. 1977	"	43	Figure 2
24 Aug.-08 Sep. 1986	OCEANOGRAPHER	215	Figure 2
11-22 Sep. 1976	DISCOVERER	141	Figure 2
22 Sep.-01 Oct. 1976	GLACIER	162	Figure 4
24 Sep.-17 Oct. 1970	"	187*	Figure 5
07-09 Oct. 1976	"	134	Figure 6
TOTAL : Chukchi Sea - 1,534 = 399 hours			
<u>BEAUFORT SEA:</u>			
02 Aug.-09 Sep. 1972	GLACIER	230*	Figure 3
02-26 Aug. 1977	ALUMIAK	202	Figure 3
05-29 Aug. 1978	"	259	Figure 3
07 Aug.-05 Sep. 1977	GLACIER	404	Figure 3
17 Aug.-03 Sep. 1976	"	113	Figure 3
18 Aug.-16 Sep. 1971	"	263*	Figure 3
19-30 Aug. 1976	ALUMIAK	108	Figure 3
26 Aug.-15 Sep. 1978	NORTHWIND	179	Figure 3
06-18 Sept. 1976	GLACIER	122	Figure 7
01-17 Oct. 1986	POLAR STAR	181	Figure 8
TOTAL : Beaufort Sea - 2,061 = 556 hours			
* 20-minute observation periods			

Table 2. Hours of observation for Ross' Gull migration conducted from Point Barrow in 1976, 1984 and 1986.

		Hours observed		
		<u>1976</u>	<u>1984</u>	<u>1986</u>
September	13		2	
	14		1	
	15		1	
	16		4	
	17		3	
	18 -		3	
	19		6	
	20		5	
	21		4	
	22		7	
	23		6	1
	24		6	0
	25		6	2
	26		4	4
	27	2	2	5
	28	2	1	6
	29	2	1	5
	30	2	3	6
October	1	2	4	5
	2	2	6	6
	3	2	5	0
	4		7	5
	5	2	5	8
	6	2	7	6
	7		6	5
	8	2	5	6
	9	2	4	6
	10	2	6	6
	11	2	2	6
	12	2	9	5
	13		9	7
	14		9	5
	15	2	4	7
	16		9	7
	17		7	7
	18		5	6
	19		6	
	20		6	
	21		3	
TOTAL HOURS:		30	186	132

Table 3. Dates and locations of aerial surveys of the Beaufort and Chukchi coasts in the fall of 1976 and 1984.

Date		Area censused
<u>CHUKCHI SEA:</u>		
1976	11 Sep.	Pt. Barrow to Cape Lisburne
	20 Sep.	" " "
	23 Sep.	Pt. Barrow to Pt. Lay
	28 Sep.	Pt. Barrow to Cape Lisburne
	13 Oct.	Pt. Barrow to Icy Cape
1984	09 Oct.	Pt. Barrow to Wainwright
	11 Oct.	Pt. Barrow to Peard Bay
<u>BEAUFORT SEA:</u>		
1976	07 Sep.	Pt. Barrow to Demarcation Pt.
	18 Sep.	Pt. Barrow to Cape Halkett
	23 Sep.	Pt. Barrow to Flaxman Is.
	04 Oct.	Pt. Barrow to Barter Island
	13 Oct.	Pt. Barrow to Tangent Pt.
1984	28 Sep.	Ocean north of Point Barrow
	03 Oct.	Plover Islands
	10 Oct.	Plover Islands and ocean to north

Table 4. Densities of Ross' Gull in the three regions of the Chukchi Sea from 22 September to 1 October 1976.

Region	Observation periods	Average density Per km ²	Percent frequency	Maximum density Per km ²
Northern Chukchi	61	4.0	40%	94.2
Central Chukchi	62	0.1	5%	3.6
Southern Chukchi	40	0.7	20%	7.9

Table 5. Densities of Ross' Gulls in relation to ice cover in the Chukchi Sea from 22 September to 1 October 1976.

Ice	Observation periods	Average density (B/km ²)	Percent freq.	Maximum density (B/km ²)
None	111	.4	14%	7.9
All ice	51	4.4	45%	94.2
Vis.to 10% cov.	11	5.6	64%	29.6
20% Cov.	27	2.1	41%	13*0
30% cov.	13	8.2	39%	94.2

Region	N	NE	E	SE	s	Sw	W	NW
NORTHERN CHUKCHI n=116	9%	3%	16%	8%	41%	3%	18%	0%
Mean direction = 246 degrees Length of mean vector = .23 Angular deviation = 71 degrees								
SOUTHERN CHUKCHI n=33	48%	0%	12%	0%	0%	0%	0%	39%
Mean direction = 30 degrees Length of mean vector = .80 Angular deviation = 36 degrees								

Table 7. Densities of Ross' Gull in the central and southern Chukchi Sea from 7 to 9 October 1976.

Region	Observation periods	Average density (per km ²)	Percent freq.	Maximum density (per km ²)
CENTRAL CHUCKHI	12	0.1	8%	1.2
SOUTHERN CHUKCHI	22	0.3	18%	1.8

Table 8. Densities of Ross' Gull in relation to ice cover in the Chukchi Sea from 24 September to 17 October 1970.

Ice Conditions	Observation periods	Average density (per sq. km)	Percent freq.	Maximum density (per sq. km)
None	41	1.3	16%	16.2
All ice	146	4.7	46%	120.0
Vis.to 10% coverage	42	1.8	29%	37.2
20% coverage	69	8.0	58%	120.0
30% coverage	35	1.8	43%	15.3

Table 9. Densities of Ross' Gulls in the western Beaufort Sea from 6 to 18 September 1976.

Ice Conditions	Observation periods	Average density (B\km ²)	Percent frequency
None	45	0.3	7%
Visible	27	0.7	19%
Pres. in transect 56 (10-25% coverage)		0.1	2%

Table 10. Densities of Ross' Gulls in the Chukchi Sea directly adjacent to Point Barrow and in the two regions of the Beaufort Sea from 1 to 17 October 1986.

Region	Observation periods	Average density (per sq. km)	Percent frequency	Maximum density (per sq. km)
Chukchi	20	0.7	50%	4.2
Western Beaufort	58	1.9	60%	14.4
Eastern Beaufort	92	0.6	24%	8.4

Table 11. Densities of Ross' Gulls in the Beaufort Sea from 1 to 18 October 1986.

Ice	Observation periods	Average density (per sq. km)	Percent frequency	Maximum density (per sq. km)
None	59	1.0	46%	2.4
Ice"	122	1.0	33%	14.4
Visible	60	1.9	57%	14.4
Pres. in transect (10-25% coverage)	62	0.1	10%	8.4

Table 12. Flight directions of Ross' Gulls in the Beaufort Sea from
1 - 17 October 1986. n = number of birds.

Region	N	NE	E	SE	s	SW	w	NW
Western Beaufort n=140 Mean direction = 103 degrees Length of mean vector = .44 Angular deviation = 69 degrees	14%	9%	44%	6%	13%	10%	5%	0%
Eastern Beaufort n=71 Mean direction = 3 degrees Length of mean vector = .55 Angular deviation = 54 degrees	23%	1%	14%	0%	10%	6%	35%	11%

Table 13. Observed daily eastward and westward passages of Ross' Gull and daily average wind direction at Point Barrow in late September and early October 1976.

Date		Ross' Gulls East	West	Wind direction (°T)
September	27	264	0	60
	28	180	0	50
	29	96	0	60
	30	1740	0	60
October	01	90	17	70
	02	177	0	90
	03	0	0	40
	04			60
	05	0	0	70
	06	0	0	60
	07			80
	08			250
	09	0	0	310
	10	0	279	220
	11	0	9	290
	12	3	6	240
	13			190
	14			330
	15	1	19	110

Table 14. Observed daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1984.

Observed East - 1984												
Date	Hours of Obs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Wind Total dir.
09/30	3			36		25				40		101 70
10/01	4			435		184			224	176		1019 70
	2	6	8	62	52	195				72	133	522 70
	3	5	69	2	0	0					0	71 70
	4	7	26	43		17	89		42	26		243 60
	5	5		211	124	11	45	36				427 60
	6	7	40	91	300			40	0	6	0	477 60
	7	6	409	388		231	102			139	22	1291 60
	8	5	278	802		222	50	12				1364 70
	9	4	46	3		0	0					49 60
	10	6		37	21	0	132		24	24	81	319 50
	11	2		457				32				489 60
	12	9	2281	750	318	165	94	20	35	12		3675 330
	13	9		125	18	177	2	0	4	0	0	326 320
	14	9		235	1	0	0	0	0	0	0	236 120
	15	4		9	14		32	100	23			178 210
	16	9		245	4	0	0	0	0	18	201	8 476 170
	17	7	0		0	0	0		0	0	0	0 210
	18	5		2	7	0		1		0		10 300
	19	6		0	0		1	0		0	0	1 360
	20	6		0	0		0	0	0			0 40
	21	3			0		0	0				0 70

Total observed east = 11,274

Table 15. Total (observed and projected) daily eastward and westward passages of Ross' Gull at Point Barrow in September and October 1984.

Total(observed and projected) - East 1984																
Date	Hours of time											Daily Total	Wind dir.			
	Obs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800					
09/30	3	33		33	36	31	25	33	33	33	40	36	331	70		
10/01	4	372		372	435	310	184	204	204	224	176	200	2681	70		
	2	6	8	62	52	195	134	134	134	134	72	133	1056	70		
	3	5	6	9	2	0	0	0	0	0	0	0	71	70		
	4	7	2	6	43	30	17	89	66	66	42	26	417	60		
	5	5			211	124	11	45	36	36	36	36	571	60		
	6	7	4	0	91	300	170	170	170	40	0	6	987	60		
	7	6	4	0	388	310	231	102	121	121	121	139	22	1962	60	
	8	5	2	7	802	512	222	50	31	12	12	12	12	1943	70	
	9	4	4	6	3	1	5	0	0	0	0	0	0	64	60	
	10	6	2	9	37	21	0	132	78	78	24	24	81	504	50	
	11	2		0	0	45	7	0	0	32	0	0	0	489	60	
	12	9	2	28	1	750	318	165	94	20	0	35	12	0	3675	330
	13	9		7	2	125	18	177	2	0	0	4	0	0	398	320
	14	9	1	17		235		1	0	0	0	0	0	0	353	120
	15	4		1	2	9	14	23	32	100	23	61	61	61	396	210
	16	9	1	25		245	4	0	0	0	0	18	201	8	601	170
	17	7		0		0	0	0	0	0	0	0	0	0	0	210
	18	5		5		2	7	0	1	1	1	0	0	0	17	300
	1	9	6	0		0	0	0	0	1	0	0	0	0	1	360
	2	0	6	0		0	0	0	0	0	0	0	0	0	0	40
	21	3		0		0	0	0	0	0	0	0	0	0	0	70
Total east = 16,516																

Table 15 (continued).

Total(observed and projected) - West 1984													
Hours of Obs.	time										Daily Wind		
	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total	dir.	

09/30	3	0	0	0	0	0	0	0	0	0	0	0	70
10/01	4	0	0	0	0	0	0	0	0	0	0	0	70
2	6	0	0	0	0	0	0	0	0	0	0	0	70
3	5	0	0	0	0	0	0	0	0	0	0	0	70
4	7	0	0	0	0	0	1	1	1	2	2	6	60
5	5	0	0	0	0	13	0	7	7	7	7	39	60
6	7	0	0	0	0	0	0	0	0	0	0	0	60
7	6	0	0	0	0	0	0	0	0	0	11	11	60
8	5	0	0	0	0	0	0	0	0	0	0	0	70
9	4	0	0	0	0	0	0	0	0	0	0	0	60
10	6	0	0	6	0	0	10	10	20	40	60	146	50
11	2	0	0	161	0	0	0	20	0	0	0	181	60
12	9	0	0	0	153	187	154	79	5	15	16	609	330
13	9	120	48	193	111	82	33	46	54	67	66	820	320
14	9	0	0	0	1	154	117	151	138	72	36	669	120
15	4	0	0	0	1	2	2	2	2	2	2	12	210
16	9	484	304	668	67	4	4	0	59	5	24	1619	170
17	7	75	111	148	137	27	28	28	11	75	140	780	210
18	5	235	226	245	60	45	45	31	19	8	14	928	300
19	6	57	57	57	105	105	154	80	75	73	60	823	360
20	6	36	43	30	36	21	31	9	0	5	5	216	40
21	3	0	0	0	0	0	0	0	0	0	0	0	70

Total west = 7,069

Table 16. Observed daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1986.

Observed East - 1986													
Hours of		time										Daily Wind	
Date	Ohs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total	dir.
09/26	4			0	0				0	1		1	330
27	5			0	0	0	0	0				0	90
28	6				0	21	0	0		0	0	21	110
29	5		4	179		3	0			39		225	90
30	6	3	0				0	13	0	2		18	90
10/01	5		5	15		3	14		9			46	50
2	6	11	14			1	0		6	0		32	50
3	0											0	120
4	6			43	13	4	14		6			80	0
5	8		0	0	6	13		0	0	0	0	19	300
6	6		46	64	52		52	52			26	292	20
7	5		0	0	0			118			9	127	70
8	6		0	4	4		0		64	39		111	30
9	6	0	6			0	2	0		0		8	50
10	6		0	0	0	0				0	0	0	240
11	7		0	4			14	171	67		15	271	70
12	4		0	2			0				0	2	150
13	7		0	3		2	7	12	20		58	102	40
14	7		18	0	0	0			0	0	0	18	360
15	7		0	2	0	0	0	0	0			2	340
16	7		0	0	0	0			0	0	0	0	180
17	7		0	6	130	0			34	76	3	249	180
18	9		4	5	7				0	0	0	16	240

Total observed east = 1,640

Table 16 (continued)

Observed West - 1986												
Date	Hours of Obs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Daily Wind Total dir.
09/26	4			0	0				0	0		0 330
27	5			39	20	4	16	0				79 90
28	6				50	0	14	2		44	9.5	205 110
29	5		0	0		4	6			0		10 90
30	6	80	33				0	15	53	0		181 90
10/01	5		6	17		9	14		0			46 50
2	6	0	0			0	0		4	1		5 150
3	0											0 120
4	5			7	17	9	14		0			47 60
5	8		43	78	62	37		60	117	0	15	412 300
6	6		9	17	9		3	17			59	114 220
7	5		233	356	142			134			2	867 270
8	6		191	175	104		37		64	39		610 330
9	6	31	6			2	0	3		3		45 150
10	6		2	11	5	1				4	1	24 240
11	6		1	16			256	357	1647		219	2496 270
12	5		2	10			3	1			0	16 150
13	7		7	105		22	13	147	174		6	474 40
14	5		100	84	118	0			59		28	389 360
15	7		98	20	15	9	0	0	0			142 340
16	7		0	2	0	0			0	0	0	2 180
17	7		0	2	0	0			43	19	101	165 180
18	6		1	0	5				21	71	27	125 240

Total observed east = 6,454

Table 17. Total (observed and projected) daily eastward and westward passages of Ross' Gulls at Point Barrow in September and October 1986.

Total (observed and projected)- East 1986													
Date	Hours of	time										Daily Wind	
	Ohs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total	dir.

09/26	4	0	0	0	0	0	0	0	0	1	1	2	330
2	7	5	0	0	0	0	0	0	0	0	0	0	90
28	6	10	10	10	10	21	21	0	0	0	0	82	110
29	5	139	95	183	179	94	3	0	24	63	39	819	90
3	0	6	3	3	0	0	0	13	13	2	2	36	90
10/01	5	18	15	20	15	12	17	14	32	9	16	168	150
2	6	11	25	14	7	8	1	0	9	6	0	81	150
3	0	9	9	9	9	10	2	3	3	2	0	55	120
4	5	64	64	71	56	17	18	14	16	6	8	334	60
5	8	0	0	0	6	19	13	7	0	0	0	45	300
6	6	106	101	110	116	52	104	104	52	39	65	849	220
7	5	0	0	0	0	0	59	177	118	63	72	489	270
8	6	3	2	4	8	4	2	0	96	103	39	261	330
9	5	5	5	5	3	3	2	2	0	0	0	28	150
10	6	0	0	0	0	0	0	5	5	5	0	15	240
11	6	3	2	4	4	9	23	185	238		56	524	270
12	5	1	1	2	2	1	1	0	0	0	0	8	150
13	7	2	2	3	3	5	9	19	32	20	97	192	40
14	5	22	27	18	0	0	0	0	0	0	0	67	360
1	5	7	2	1	2	0	0	0	0	0	0	7	340
16	7	0	0	0	0	0	0	0	0	0	0	0	180
17	7	3	3	6	136	130	0	25	59	110	79	551	180
18	6	9	9	9	12	8	8	8	4	0	0	67	240

Total east = 4,679

Table 17 (continued)

Total(observed and projected) - West 1986													
Date	Hours of	time										Daily Wind	
	Ohs.	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	Total	dir.
<hr/>													
09/26	4	0	0	0	0	0	0	0	0	0	0	0	330
27	5	29	29	39	20	4	16	0	8	8	8	161	90
28	6	25	25	25	50	0	14	2	23	44	95	303	110
29	5	0	0	0	2	4	6	14	14	0	7	47	90
30	6	80	33	16	16	16	0	15	53	0	26	255	90
10/01	5	11	6	17	13	9	14	7	0	3	3	83	150
2	6	0	0	0	0	0	0	2	4	1	2	9	150
3	0	0	0	0	0	0	0	0	0	0	0	0	120
4	5	12	12	7	17	9	14	7	0	3	3	84	60
5	8	60	43	78	62	37	48	60	117	0	15	520	300
6	6	13	9	17	9	6	3	17	38	38	59	209	220
7	5	295	233	356	142	138	138	134	67	67	2	1572	270
8	6	183	191	175	104	71	37	51	64	39	62	976	330
9	6	3	1	6	4	4	2	0	3	3	3	59	150
10	6	6	2	11	5	1	2	2	2	4	1	36	240
11	6	8	1	16	136	136	256	357	1647	933	219	3709	270
12	5	6	2	10	6	6	3	1	1	1	0	35	150
13	7	56	7	105	63	22	13	147	174	90	6	683	40
14	5	92	100	84	118	77	77	37	59	44	28	716	360
15	7	59	98	20	15	9	0	0	0	0	0	201	340
16	7	0	0	2	0	0	0	0	0	0	0	2	180
17	7	1	0	2	0	0	15	30	43	19	101	211	180
18	6	1	1	0	5	13	13	13	21	71	27	165	240

Total west = 10,034

Table 18. Wind conditions in relation to principal direction of movement of Ross' Gull at Point Barrow.

	principal dir of flight	avg. dir (deg.)	angular deviation (deg.)	mean vector	avg. speed (m.p.h.)
1976					
27 Sept. - 2 Oct.	east	63	13	.970	17
3 - 8 Oct.	none	60	48	.646	13
10 - 15 Oct.	west	237	61	.431	14
1984					
30 Sept. - 9 Oct.	east	66	5	.996	18
10 - 20 Oct.	west	190	73	.168	15
1986					
26 Sept. - 4 Oct.	none	94	53	.568	8
5 - 20 Oct.	west	109	68	.294	14

Table 19. Linear densities (birds per linear km) of Ross' Gull between Atanik and Cape Halkett in 1976. See Figure 21 for location of coastal sections.

Date	COASTAL SECTION				
	A	B	c	D	E
7 Sept.			0	0	0
11 Sept.	0	0	-	-	-
18 Sept.			0	-	-
20 Sept.	0	0	-	-	-
23 Sept.	0	0	12	.1	0
28 Sept.	0	.4	-	-	-
4 Oct.			28	-	.1
13 Oct.	.1	.1	.1	-	-

Table 20. Percent of days with wind direction favorable for eastward and westward movement of Ross' Gull at Barrow in September and October 1975-1987.

	September						October			
	<u>1-5</u>	<u>6-10</u>	<u>11-15</u>	<u>16-20</u>	<u>21-25</u>	<u>26-30</u>	<u>1-5</u>	<u>6-10</u>	<u>11-15</u>	<u>16-20</u>
Favorable eastward (360-135 deg.)	54%	62%	58%	49%	46%	78%	62%	62%	63%	60%
Favorable westward (180-315 deg.)	38%	28%	34%	34%	45%	14%	17%	20%	20%	23%
Ratio east to west	.70	.45	.59	.69	.98	.18	.27	.32	.32	.38

Table 21. Average wind direction and speed at Barrow in September and October, 1975-87.

Year	Avg. direction (deg.)		Avg. speed (m.p.h.)	
	Sept	Ott	Sept	Ott
1975	290	40	11	10
1976	70	30	11	14
1977	130	70	13	17
1978	60	50	13	12
1979	60	60	12	16
1980	60	70	13	10
1981	60	50	12	13
1982	70	360	14	13
1983	250	80	12	12
1984	80	60	12	15
1985	300	360	13	14
1986	200	160	14	12
1987	70	90	14	13

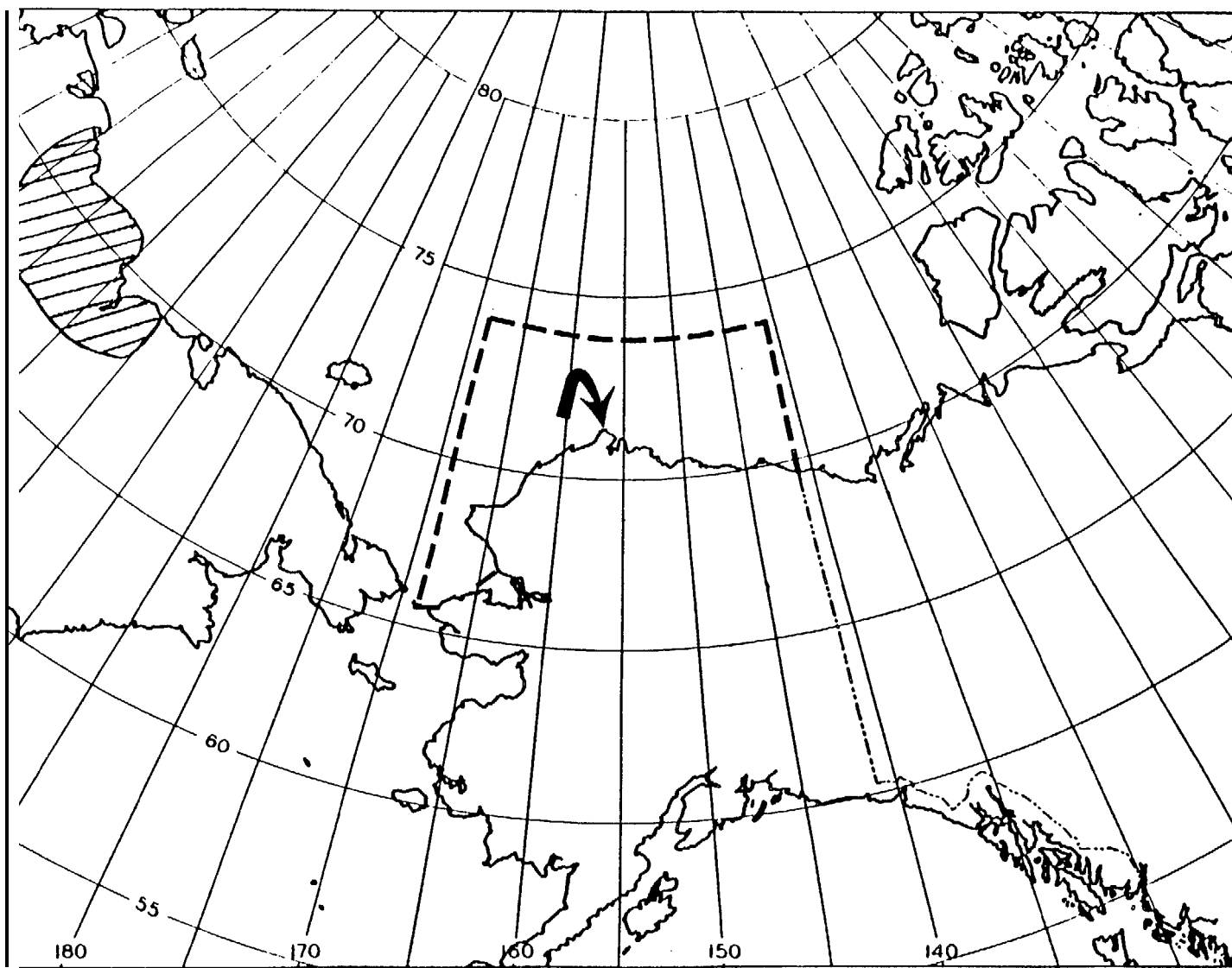


Figure 1. Location of Ross' Gull breeding grounds in Siberia (hatched area), study area discussed in this report (enclosed by dotted line) and Point Barrow (arrow).

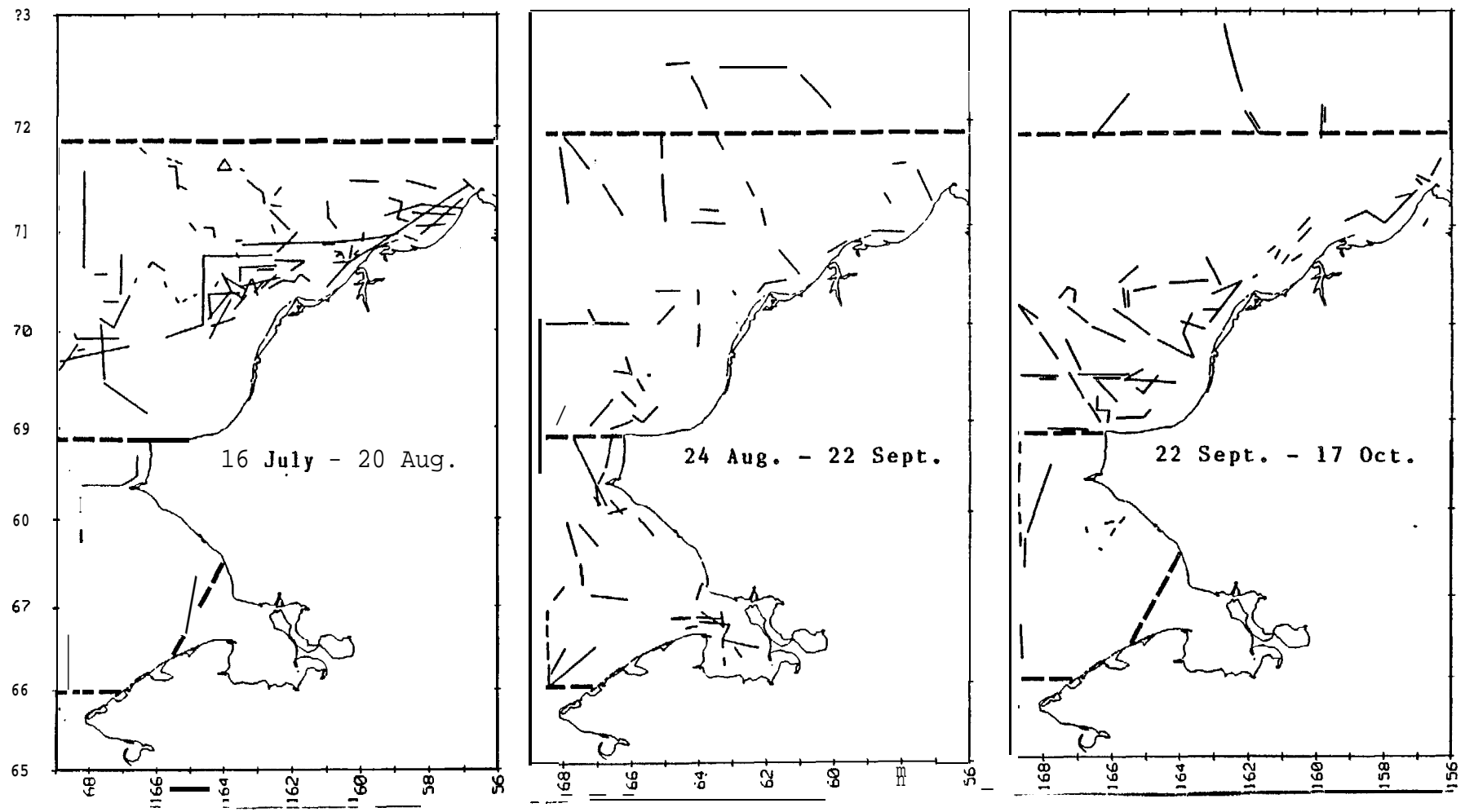


Figure 2. Location of pelagic observations in the Chukchi Sea by time period.

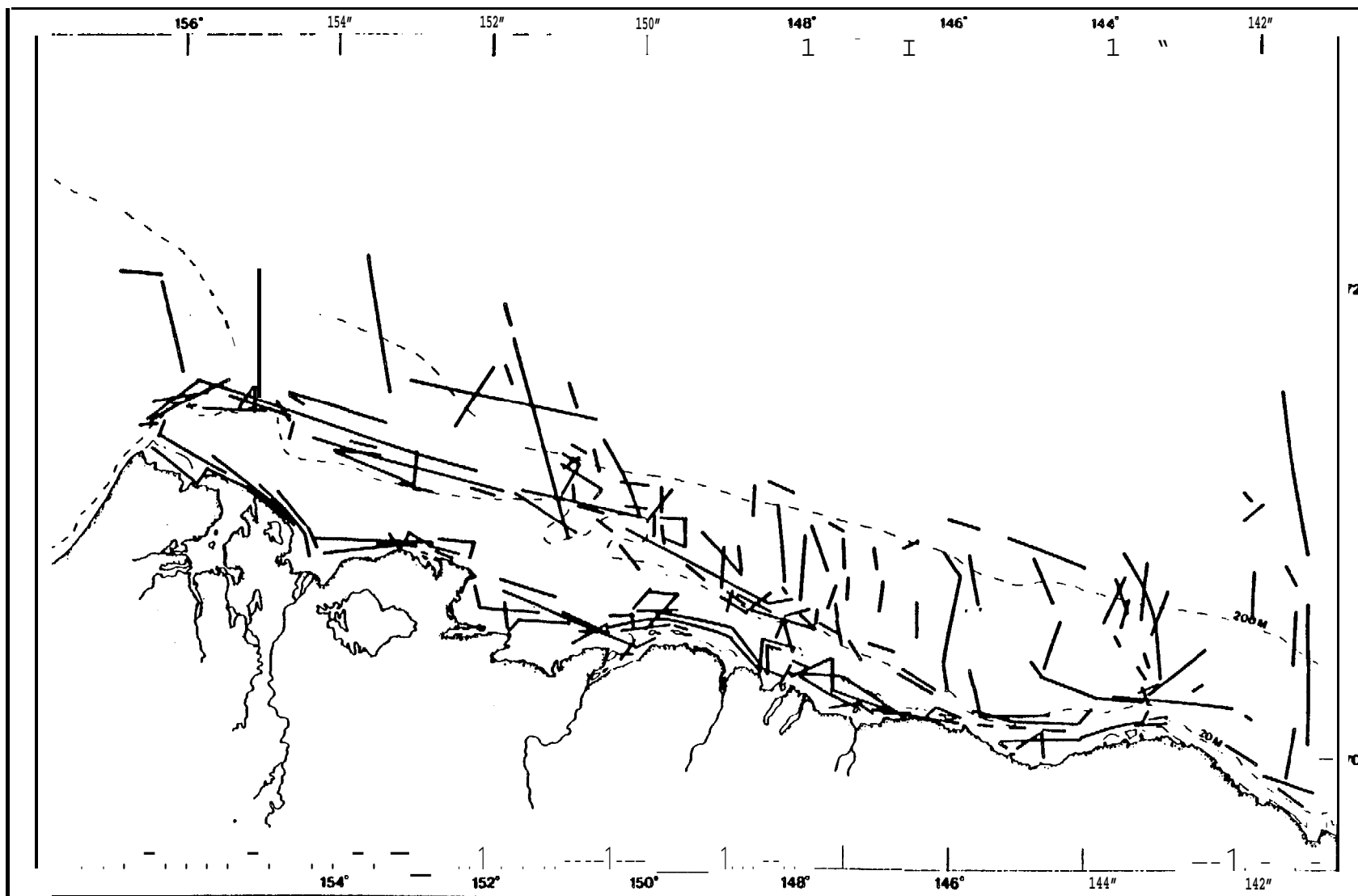


Figure 3. Location of pelagic observations in the Beaufort Sea prior to the fall arrival of Ross' Gulls in Alaskan waters.

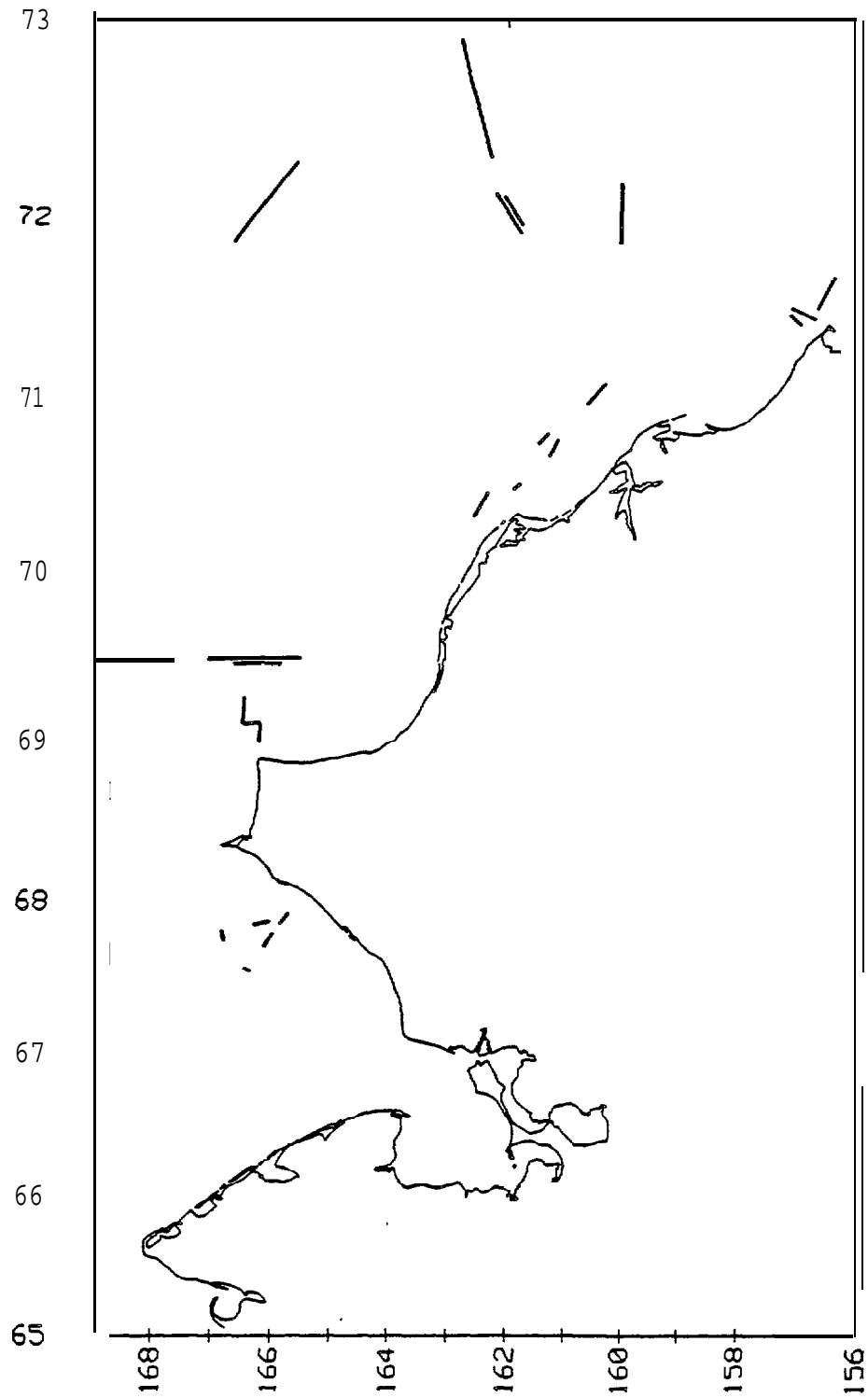


Figure 4. Cruise track where seabird censusing was conducted from 22 September - 1 October 1976.

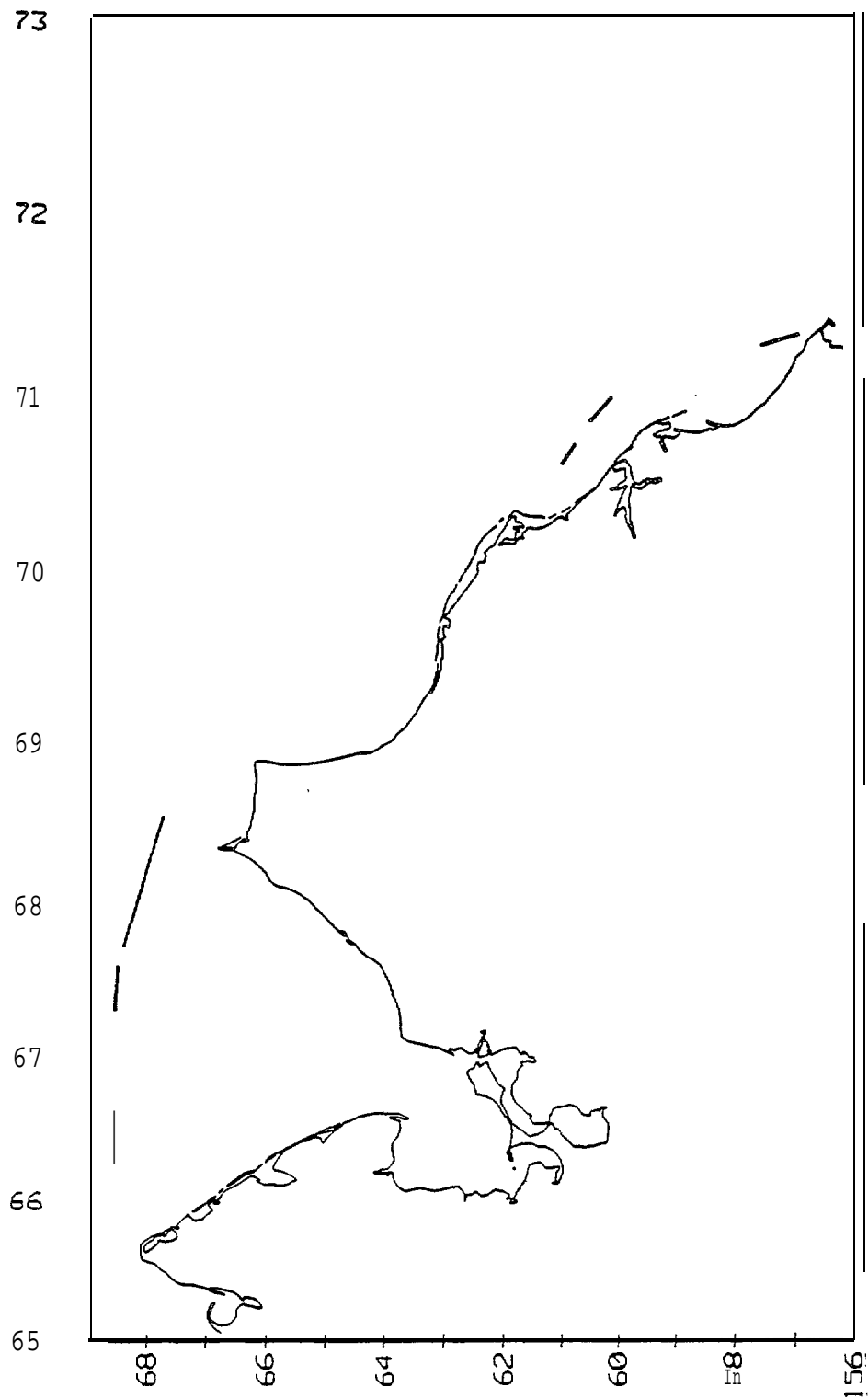


Figure 5. Cruise track where seabird censusing was conducted from 7 to 9 October 1976.

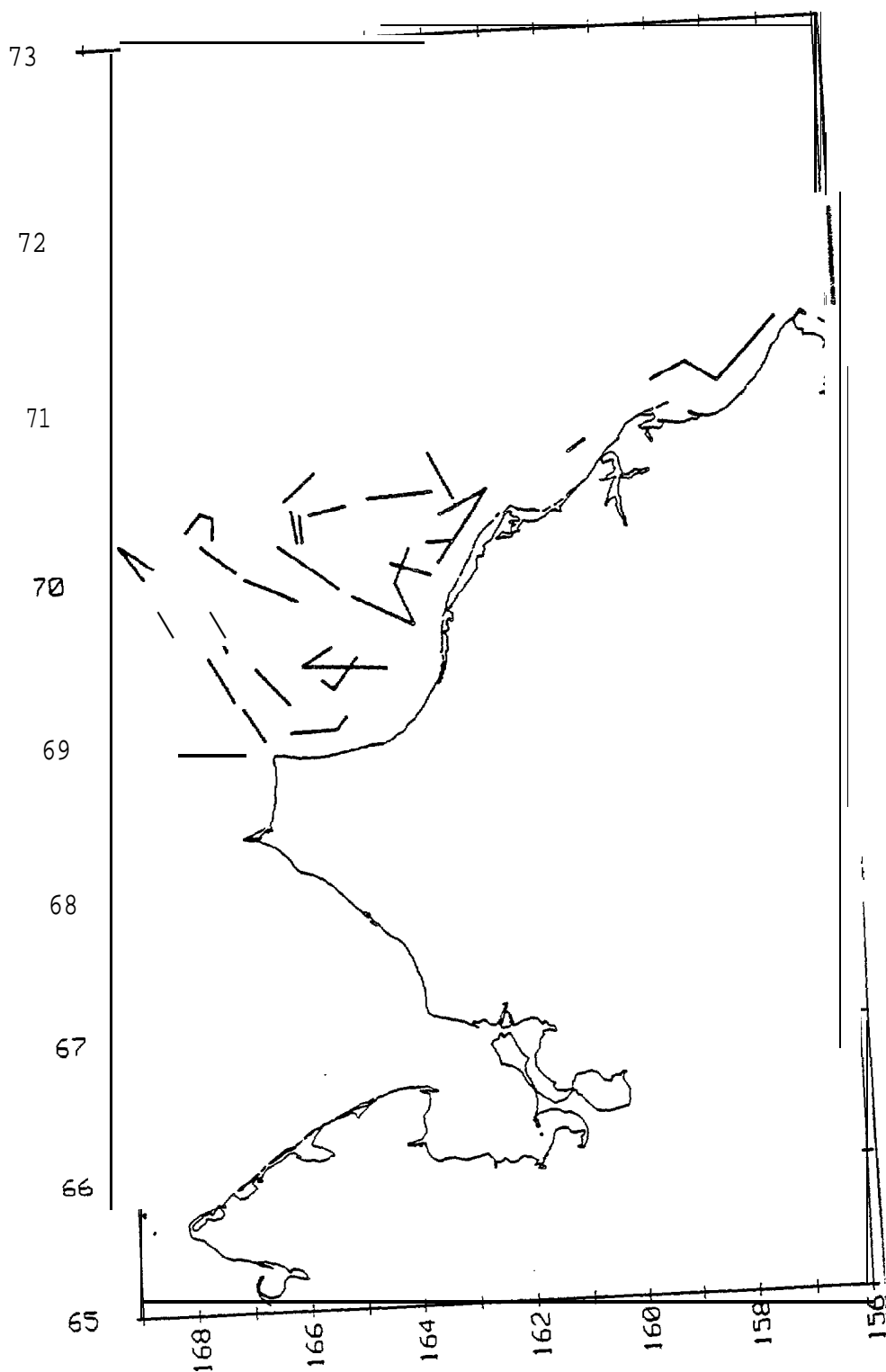


Figure 6. Cruise track where seabird censusing was conducted from 24 September - 17 October 1970.

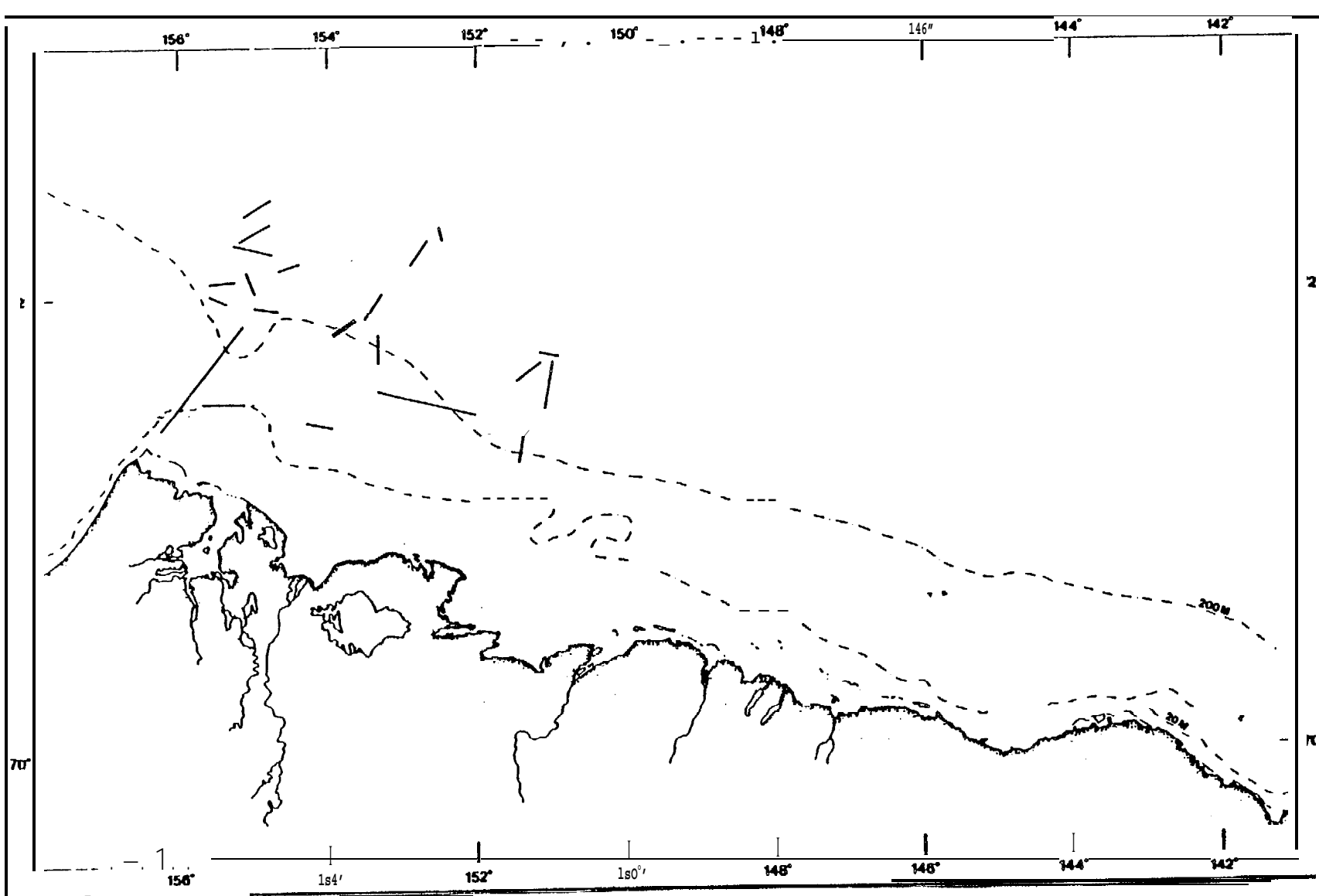


Figure 7. Cruise track where seabird censusing was conducted from 6 to 17 September 1976.

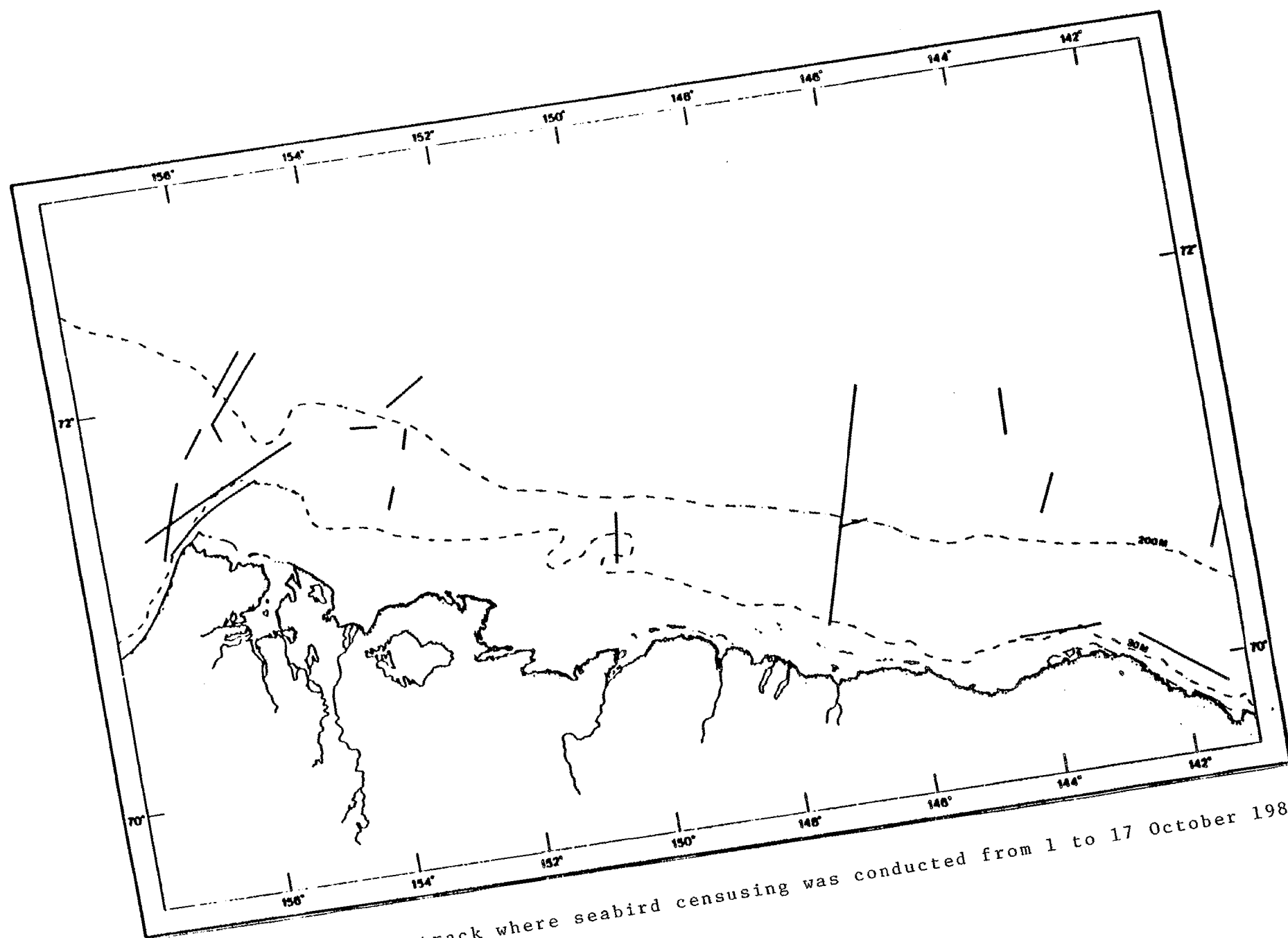


Figure 8. Cruise track where seabird censusing was conducted from 1 to 17 October 1986.

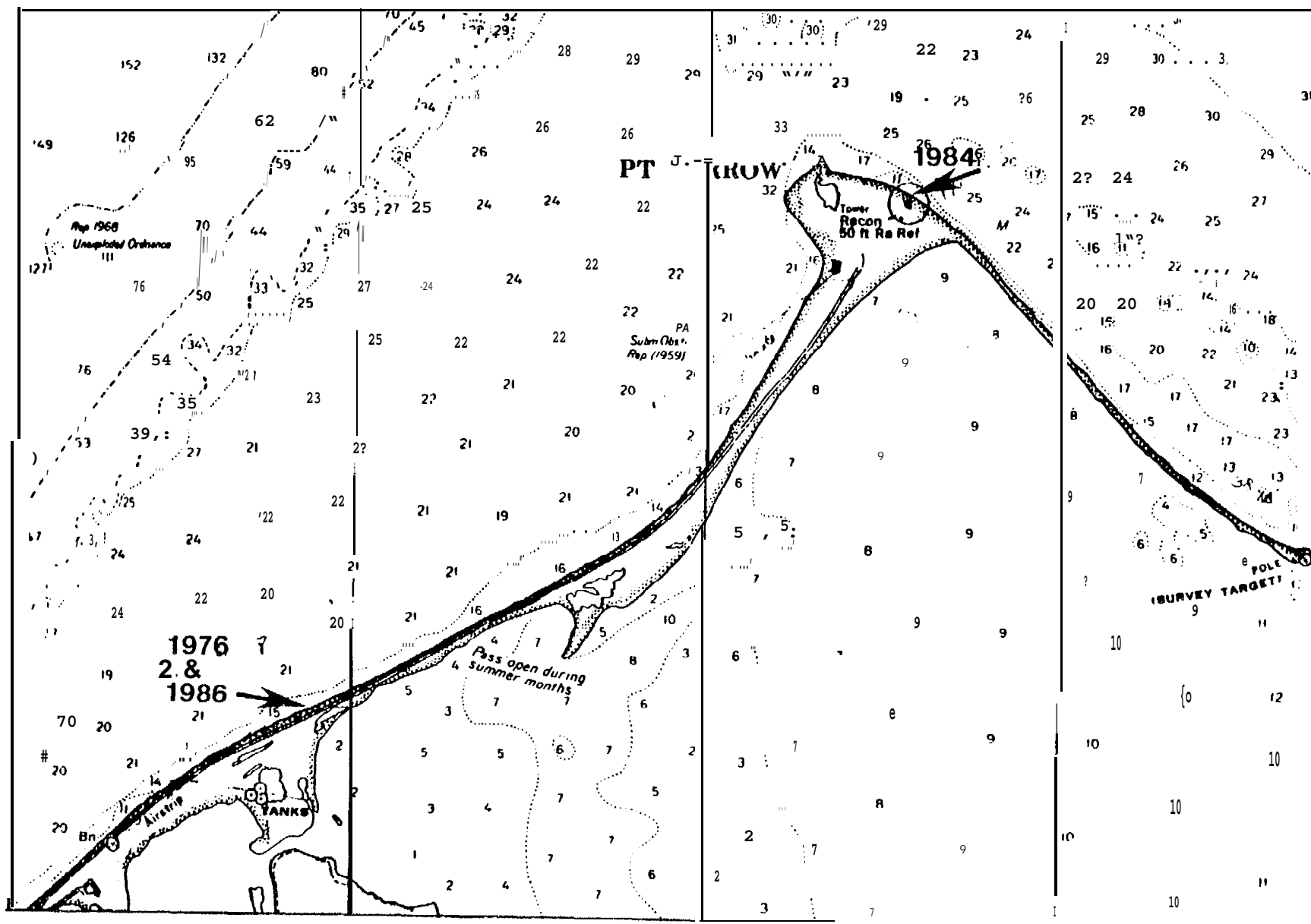


Figure 9. Location where migrant watches were conducted at Point Barrow in 1976, 1984, and 1986.

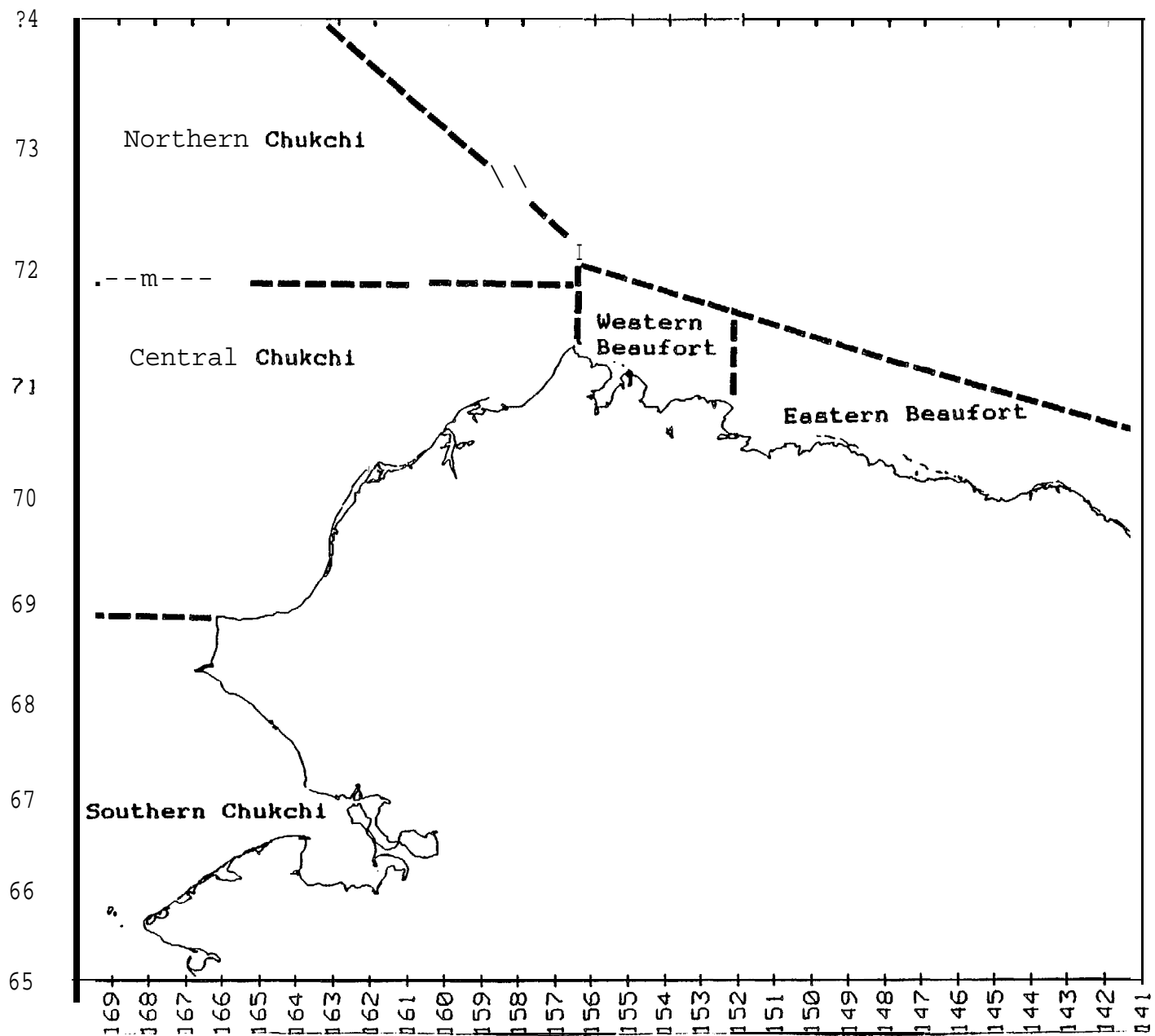


Figure 10. The Alaskan Chukchi and Beaufort Seas with regions discussed in text.

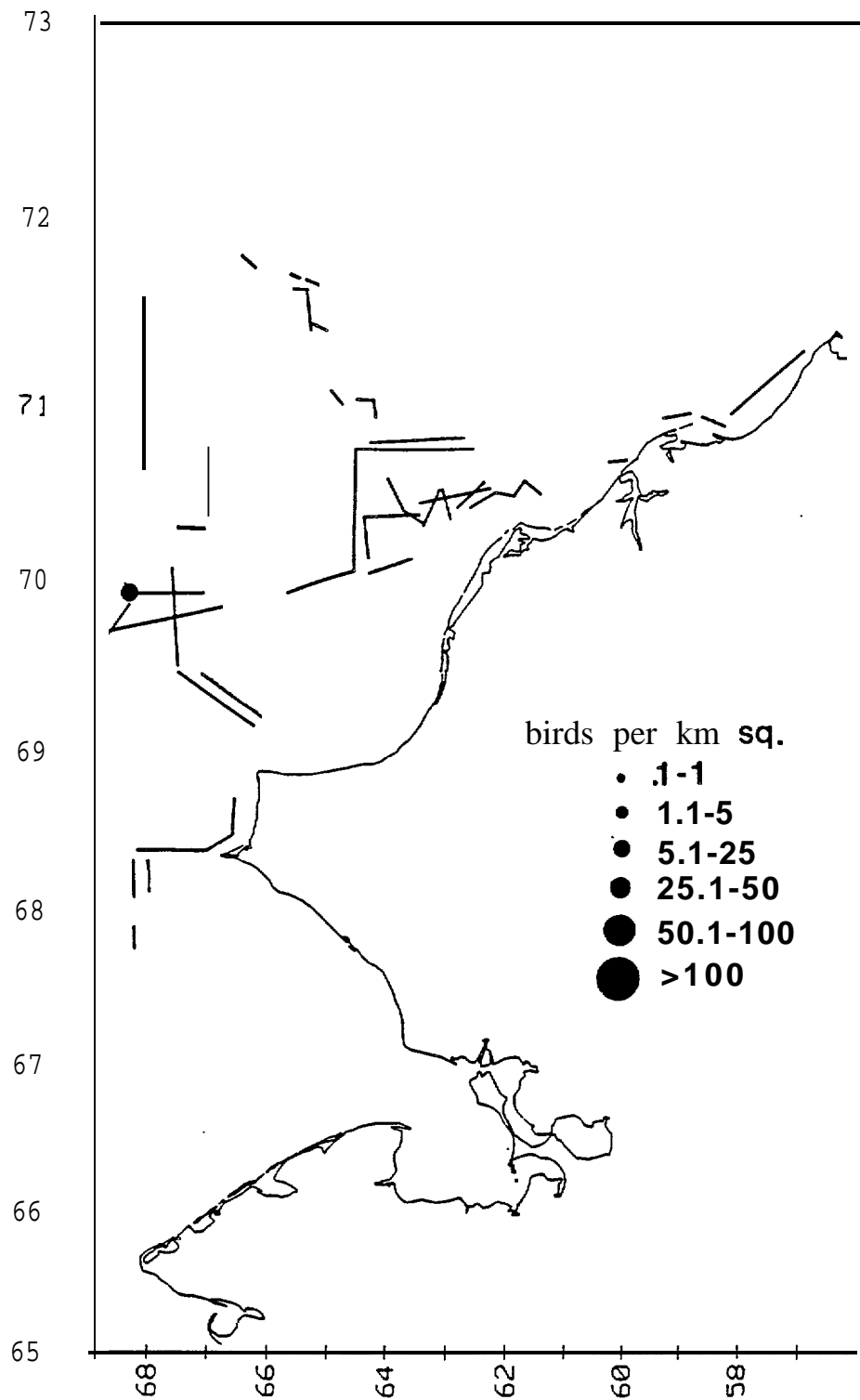


Figure 11. Densities of Ross' Gull in the Chukchi Sea from 1 to 20 August 1975.

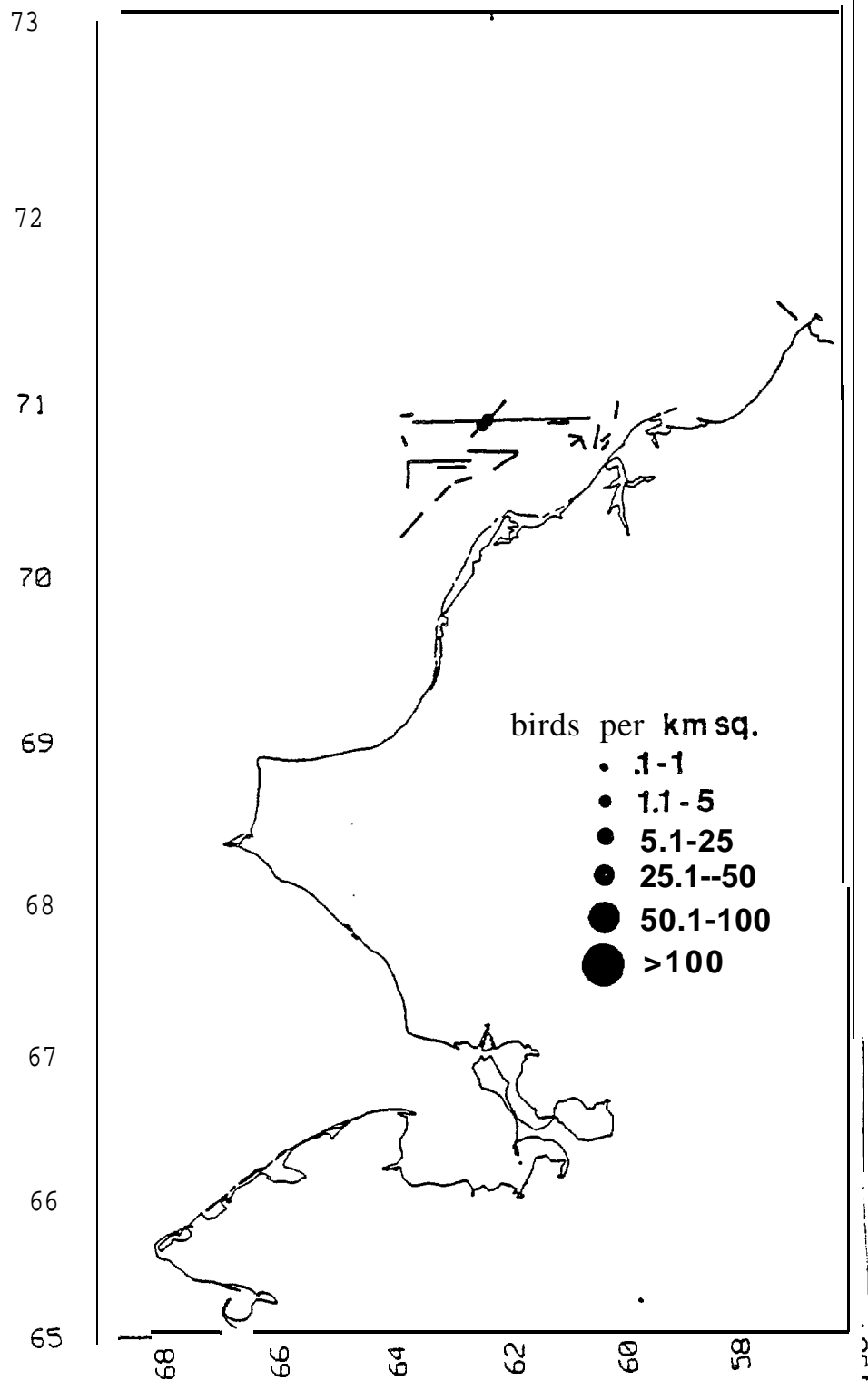


Figure 12 Densities of Ross' Gull in the Chukchi Sea from 7 to 14 August 1976.

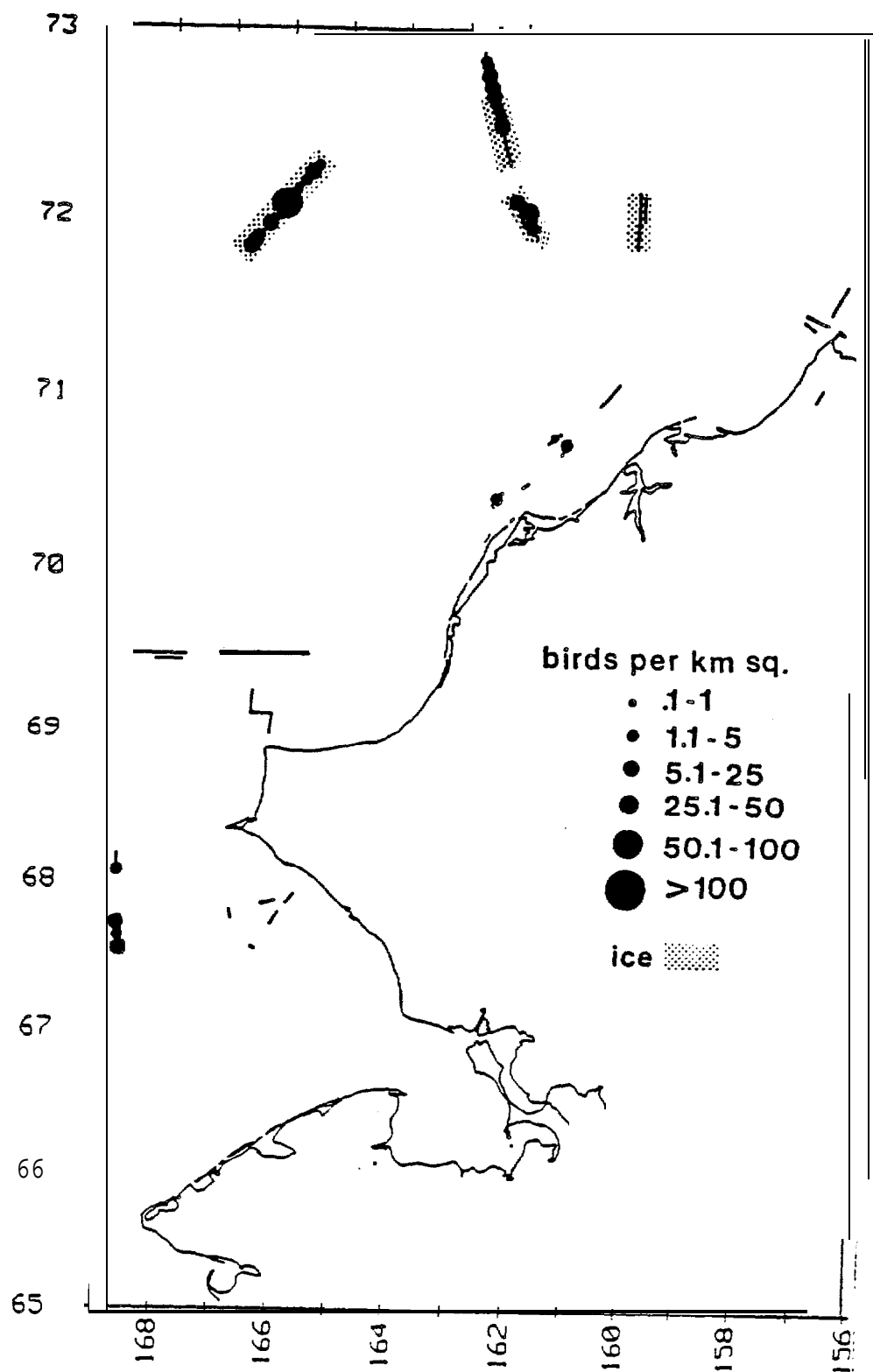


Figure 13. Densities of Ross' Gull in the Chukchi Sea from 22 September - 1 October 1976.

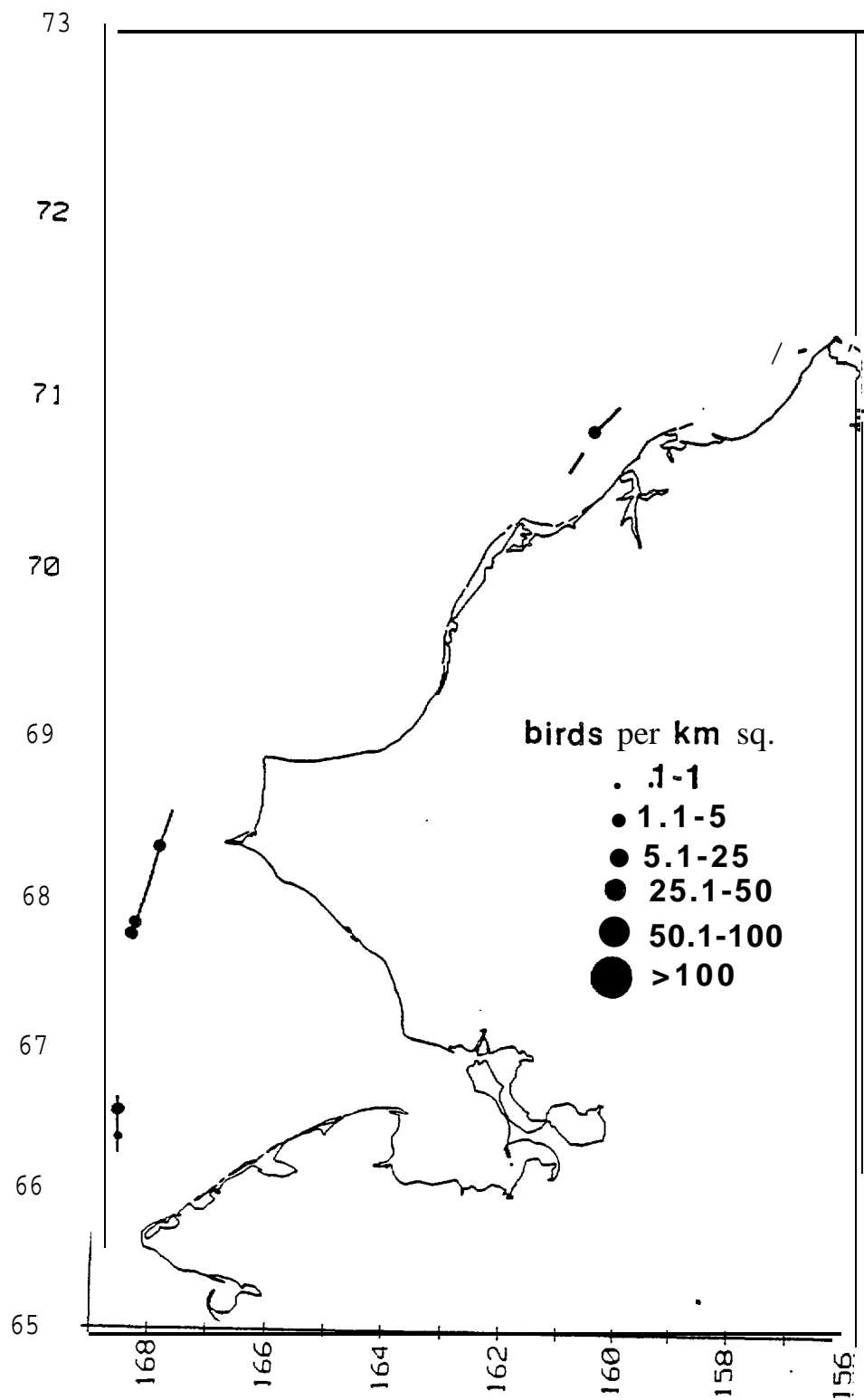


Figure 14. Densities of ^{ROSS'} Gull in the Chukchi Sea from 7 to 9 October 1976.

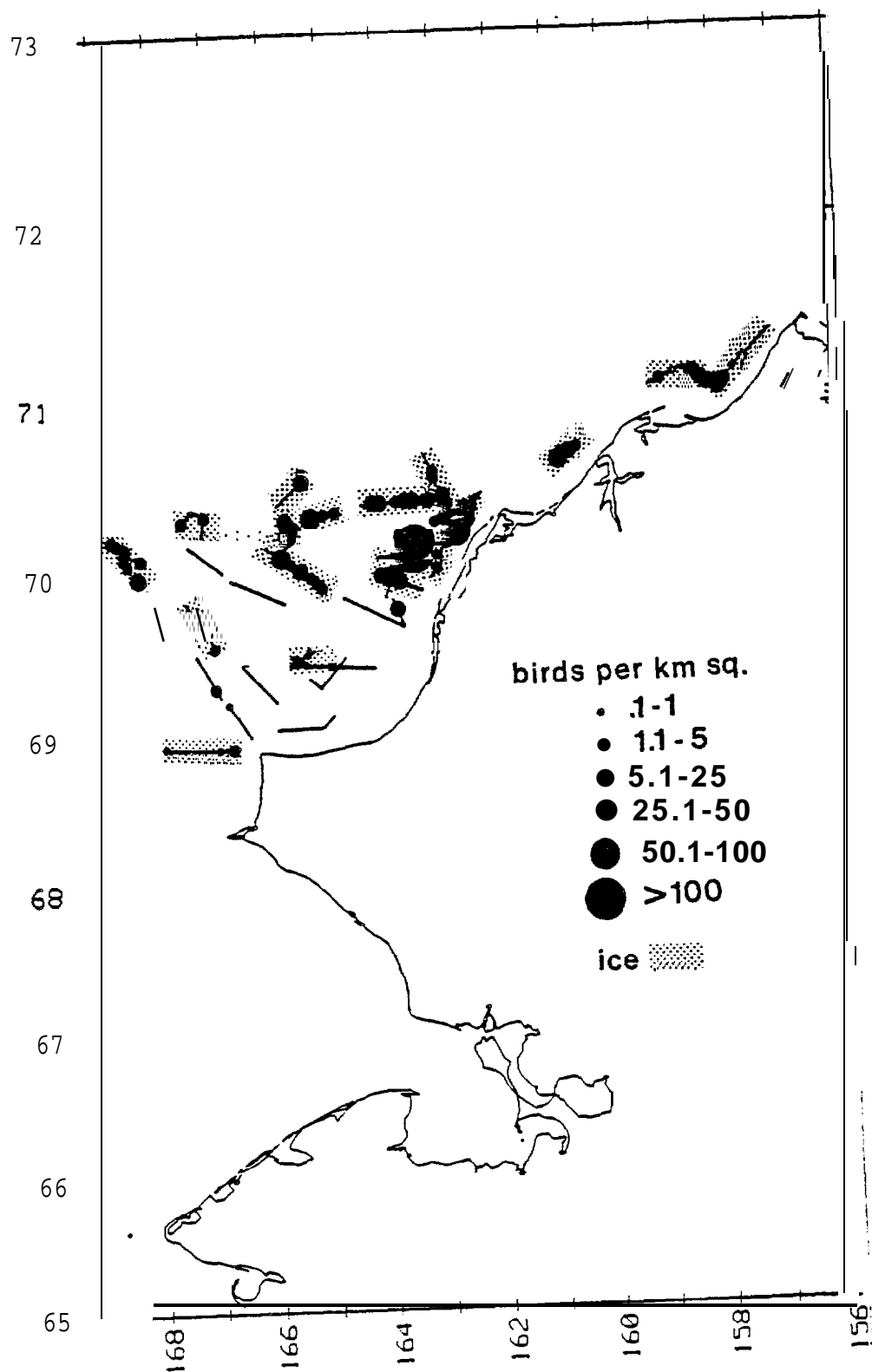


Figure 15. Densities of Ross' Gull in the Chukchi Sea from 24 September - 17 October 1970.

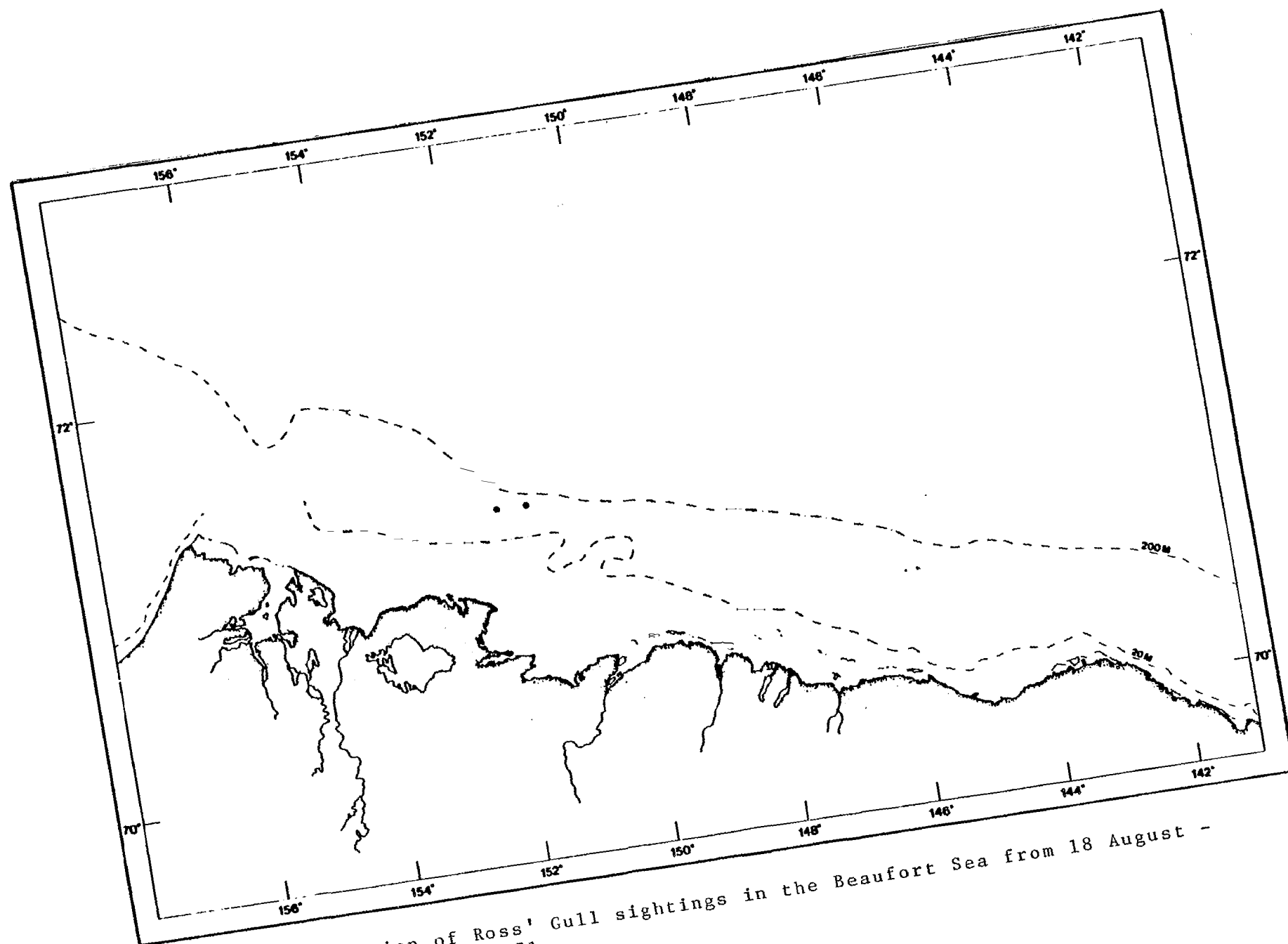


Figure 16. Location of Ross' Gull sightings in the Beaufort Sea from 18 August - 16 September 1971.

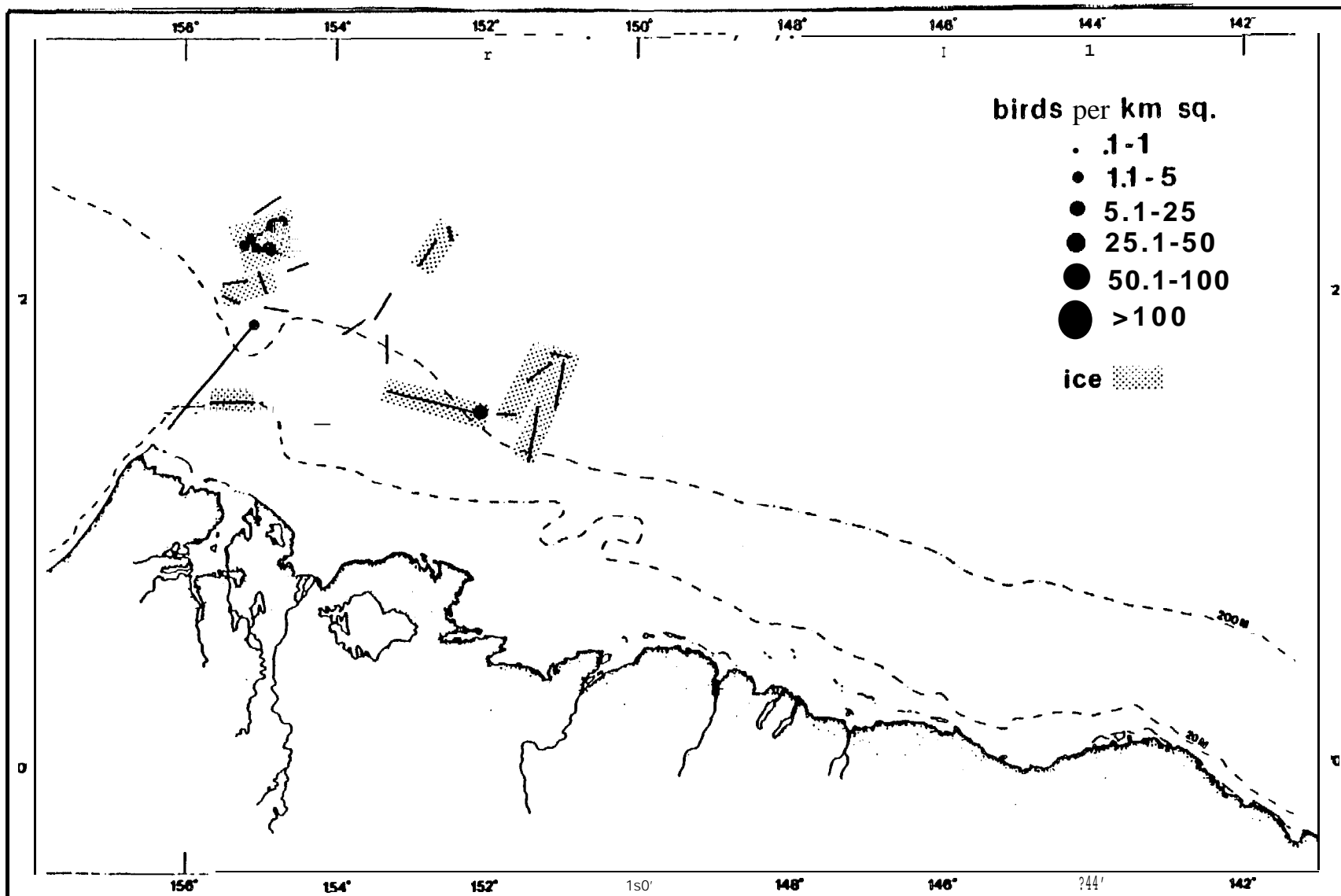


Figure 17. Densities of Ross' Gull in the Beaufort Sea from 1 to 17 October 1986.

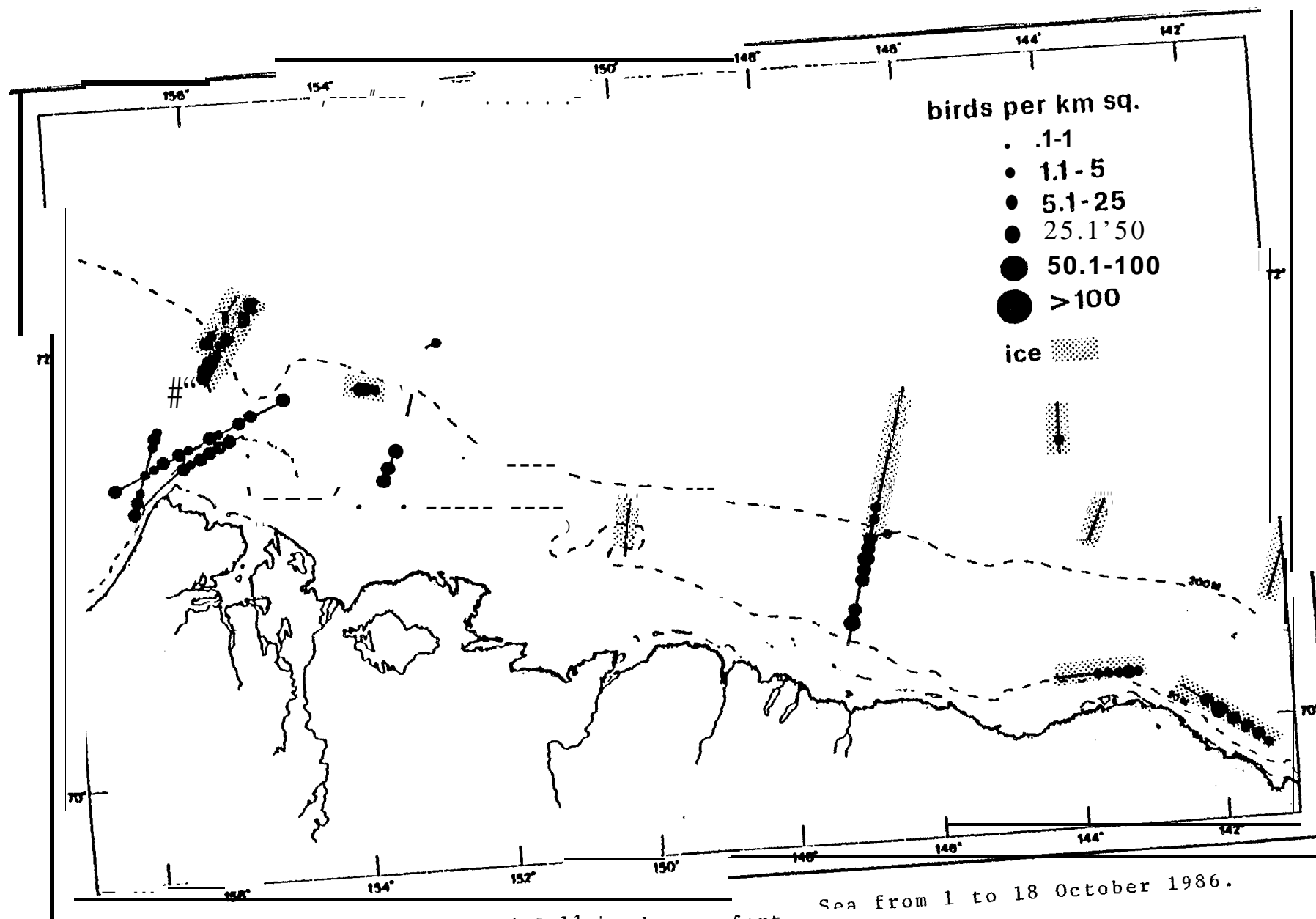


Figure 18. Densities of Ross Gull in the Beaufort Sea from 1 to 18 October 1986.

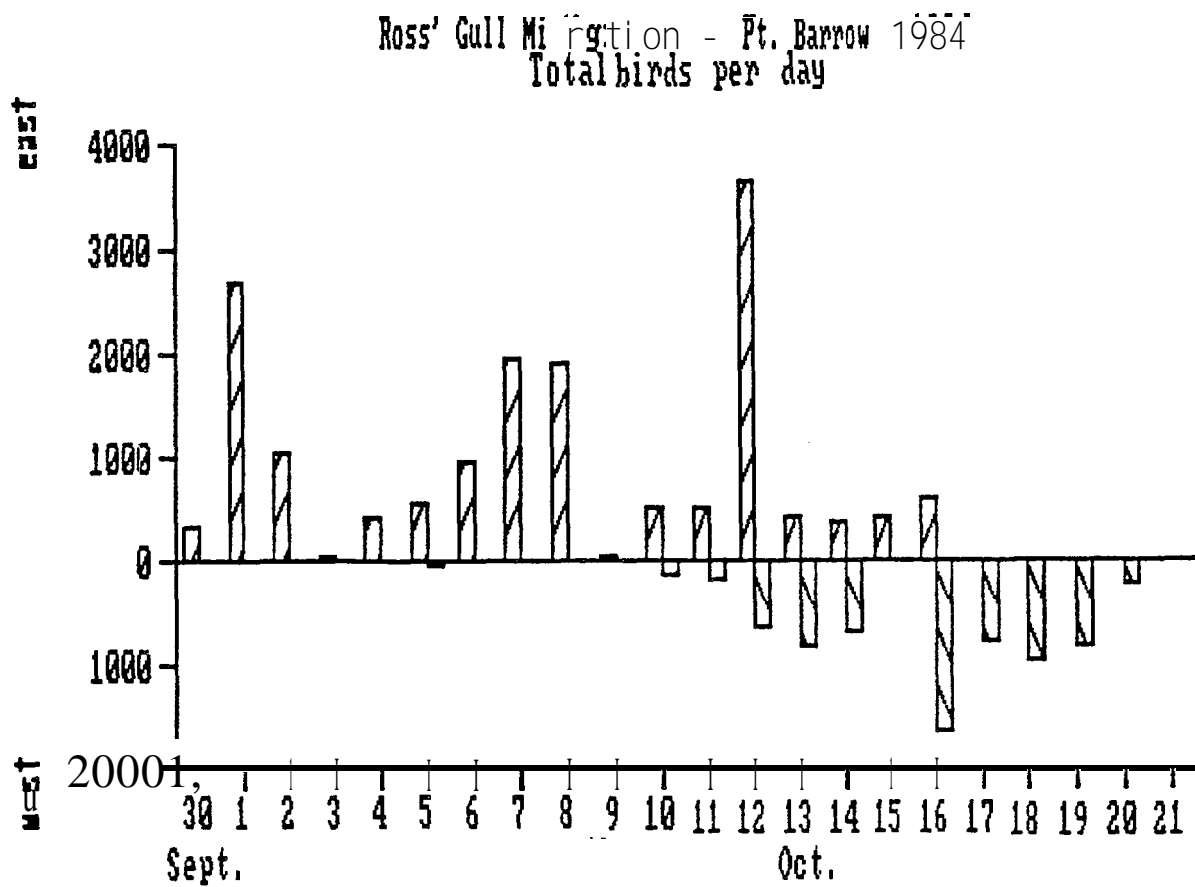


Figure 19. Total eastward and westward passages per day (observed and projected) of Ross' Gull at Point Barrow in September and October 1984.

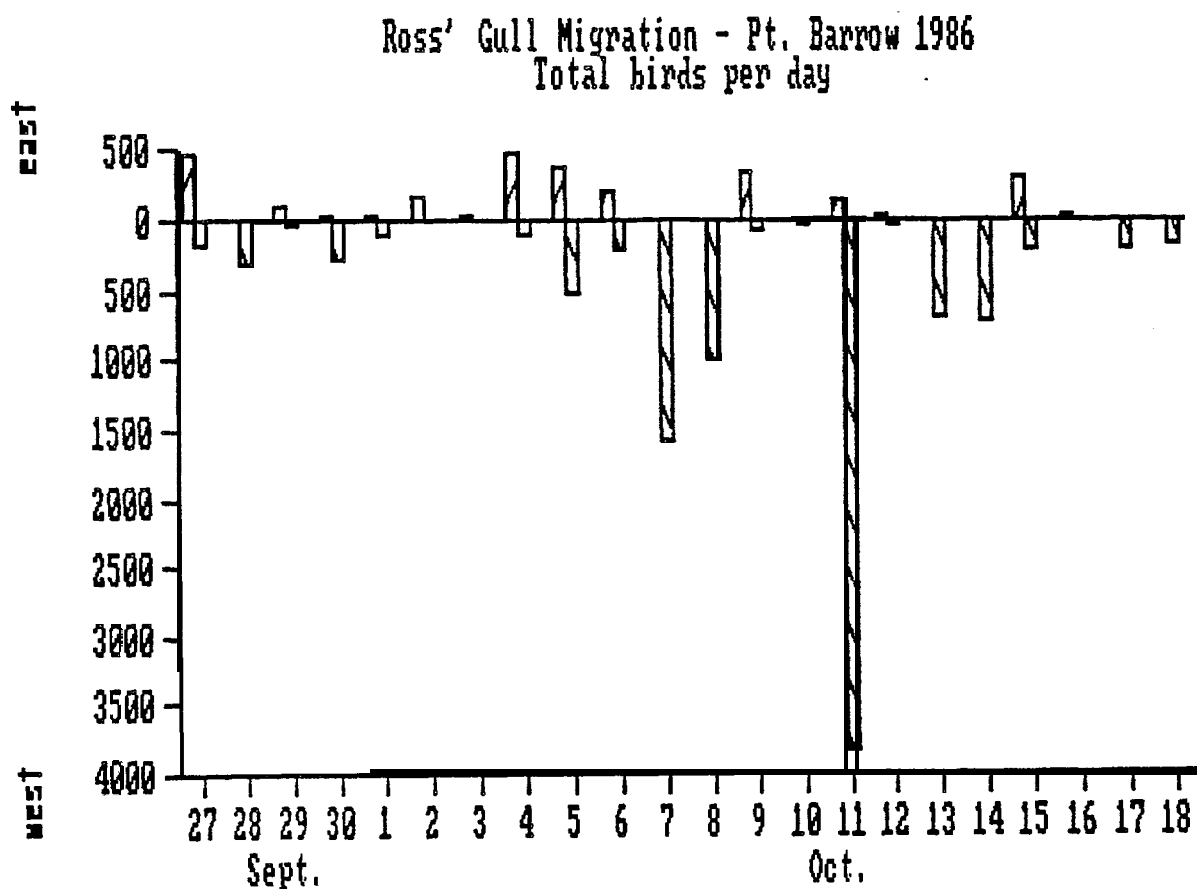


Figure 20. Total eastward and westward passages per day (observed and projected) of Ross' Gull at Point Barrow in September and October 1986.

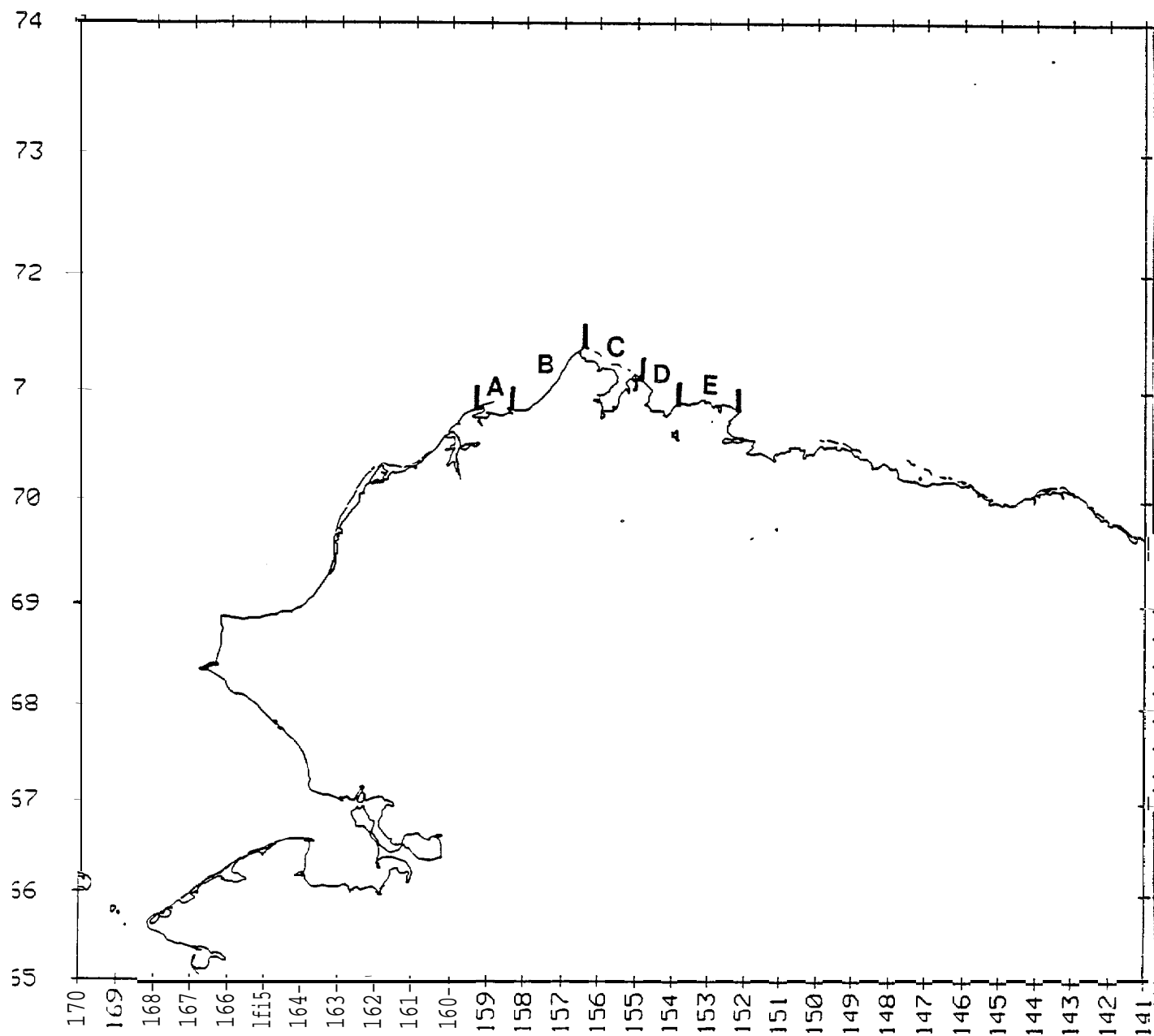


Figure 21. Location of coastal sections where Ross' Gulls were encountered on aerial censuses.

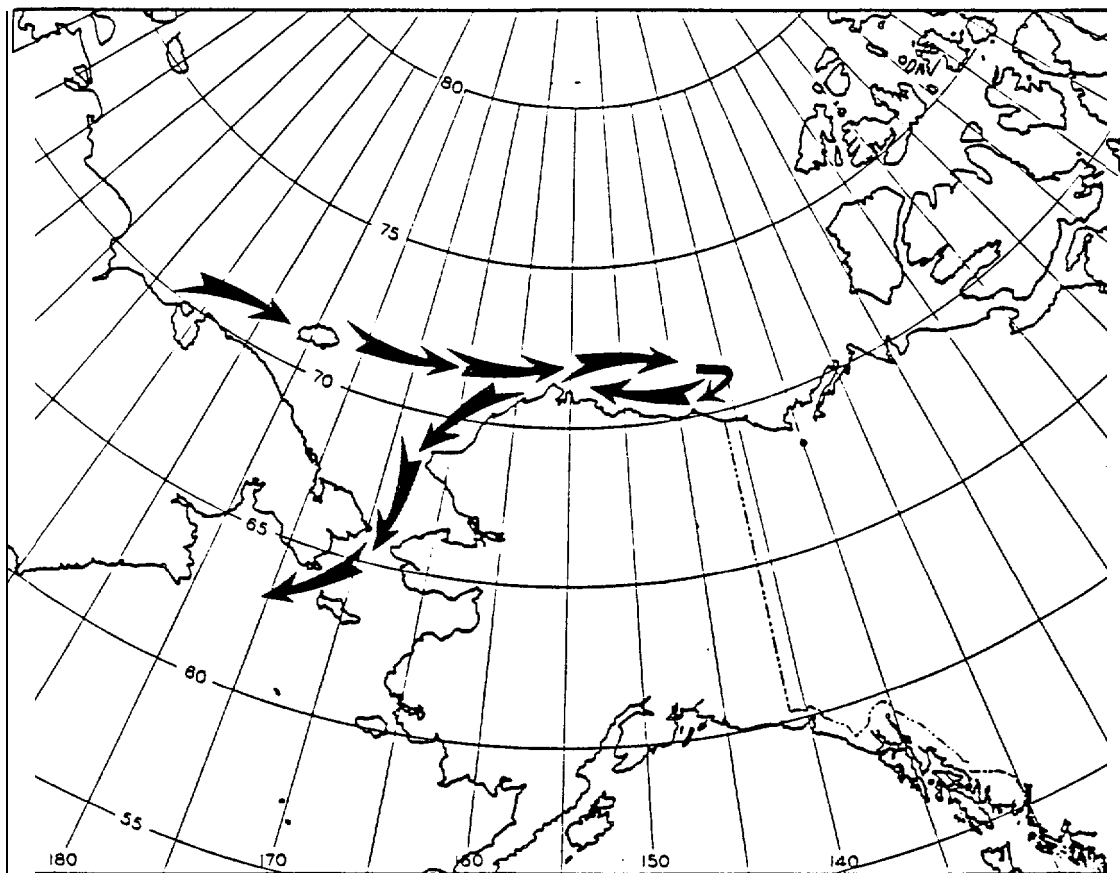


Figure 22. General pattern of migration of Ross' Gull in Alaskan waters from September through November.